

DarkSide50 Detector

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IHEP, Beijing



Image Credit: Fermilab

Outline

- Liquid Argon TPC
- Cryostat and Cryogenics
- Gas System
- Scintillator Neutron Veto
- Water Shielding

TPC General Requirements

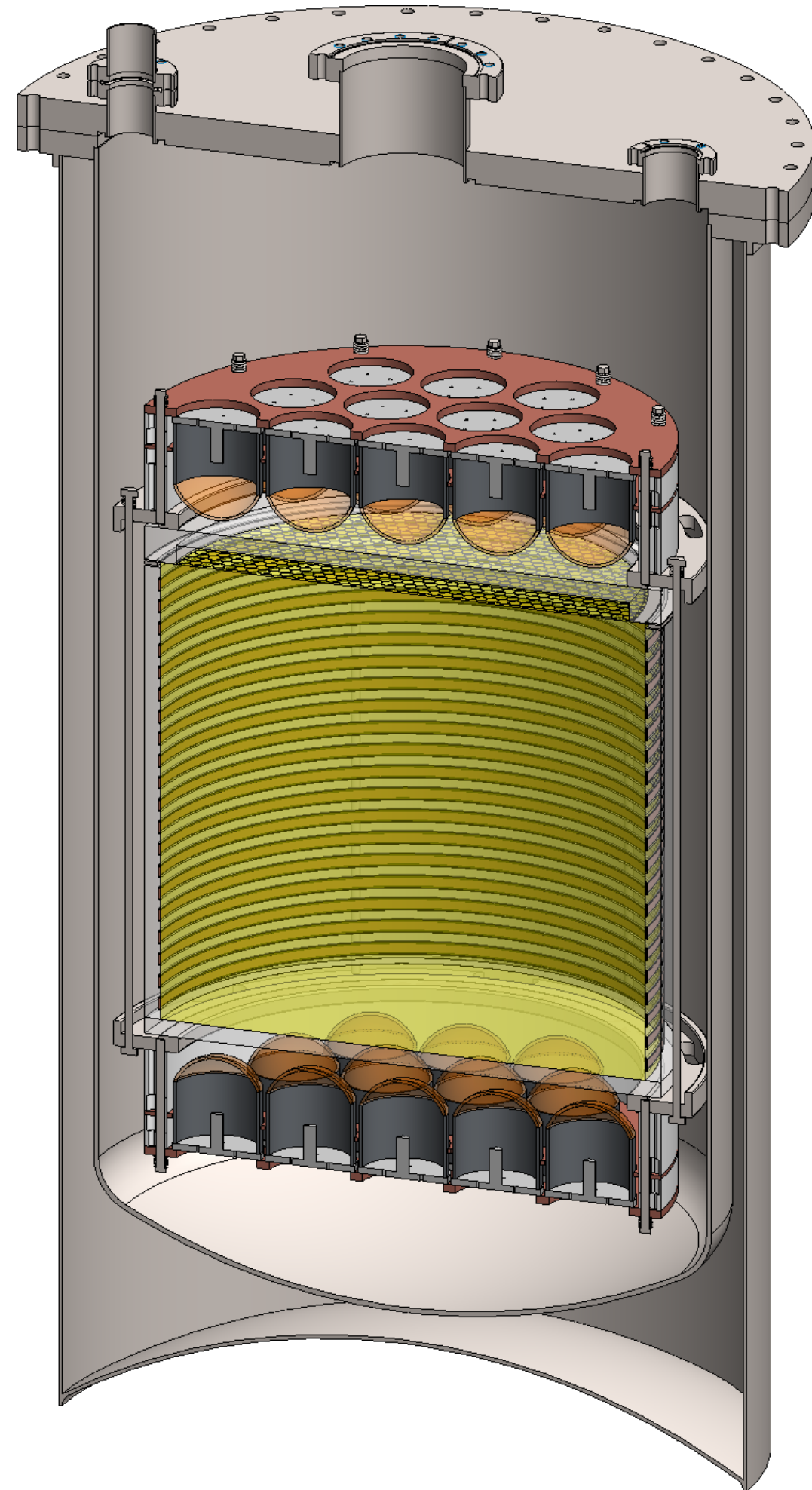
- Background Discrimination
 - Light Yield (PMTs, WS) (S1)
 - Purity (Electron Lifetime) (S2)
 - Cathode HV for Drift Field (S2)
- Stability
- Safety

DarkSide-50

- first implementation of the new technologies
- dual-phase TPC
- 50 kg DAr active mass

*sensitivity 10^{-45} cm^2 in 3-yrs
background-free operation*

*demonstrate potential of the
technology for multi-ton year
background-free sensitivity*



DarkSide Photosensors

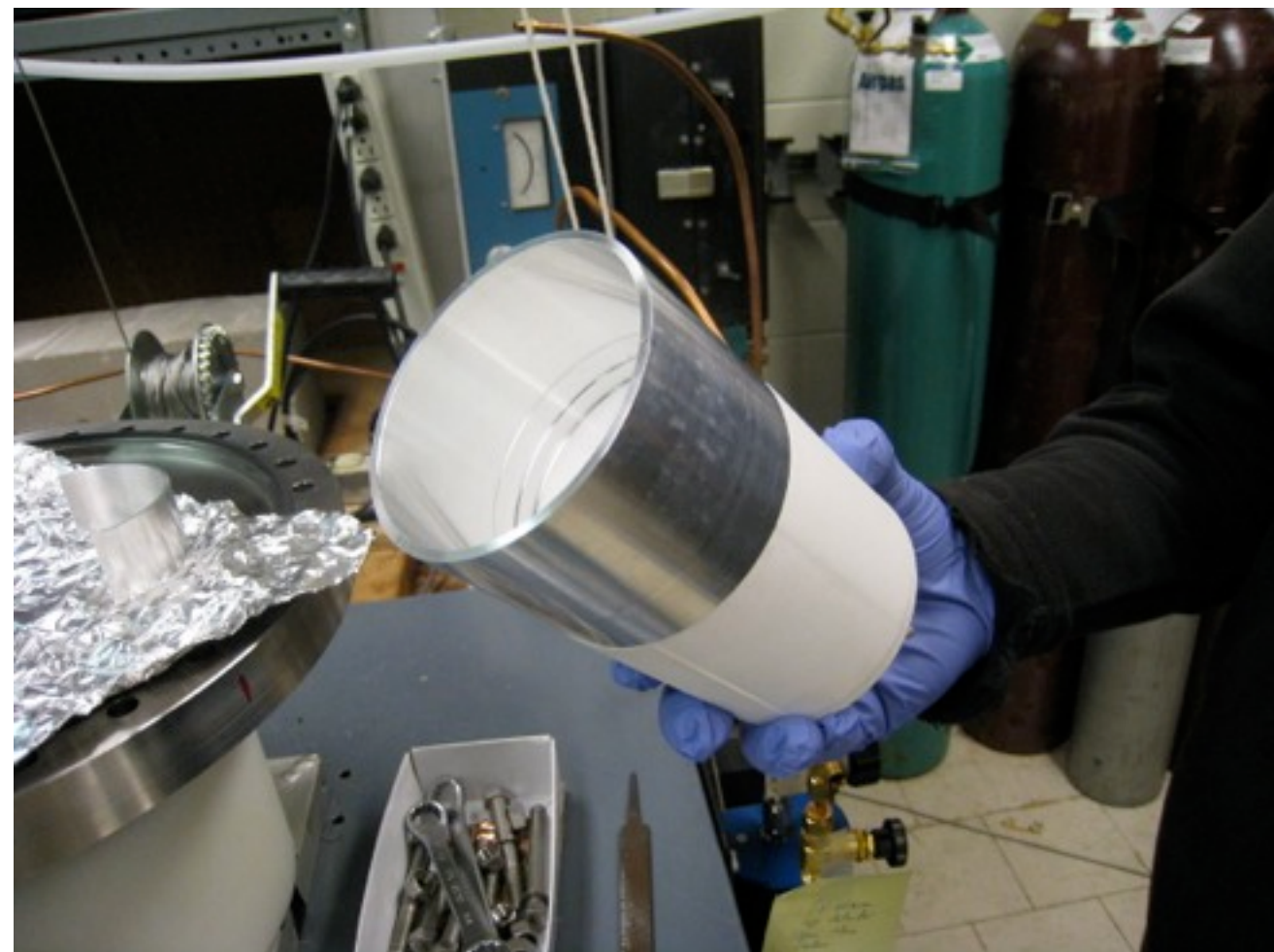
- EM backgrounds in DarkSide are suppressed to the necessary levels for tonne-year sensitivity by ultra-pure DAr discrimination
- Internal neutron backgrounds (mostly from (α, n) in conventional PMTs) would still interfere with tonne-year sensitivity
- Zero background operation of 50 kg detector possible with metal-bulb Hamamatsu R11065
- DarkSide collaboration procured a set of Hamamatsu R11065 for first installation

Hamamatsu R11065
(32% QE)

2 kg LAr
0.7 kg active mass

Light Yield:
 7.3 ± 0.2 p.e./keV

@Princeton



DarkSide & QUPIDs

- Excellent single (and 2-, 3-, 4-) PE response
- >30% QE at LAr temperature
- Prototypes already delivered from Hamamatsu, mass production process being developed
- Routine delivery to commence soon - first implementation reserved for DarkSide and XENON collaborations
- Use of QUPIDs removes the dominant internal neutron source in DarkSide, reducing this background below that required for tonne-year sensitivity

Qupid Concept

Photo Cathode
(-6 kV)

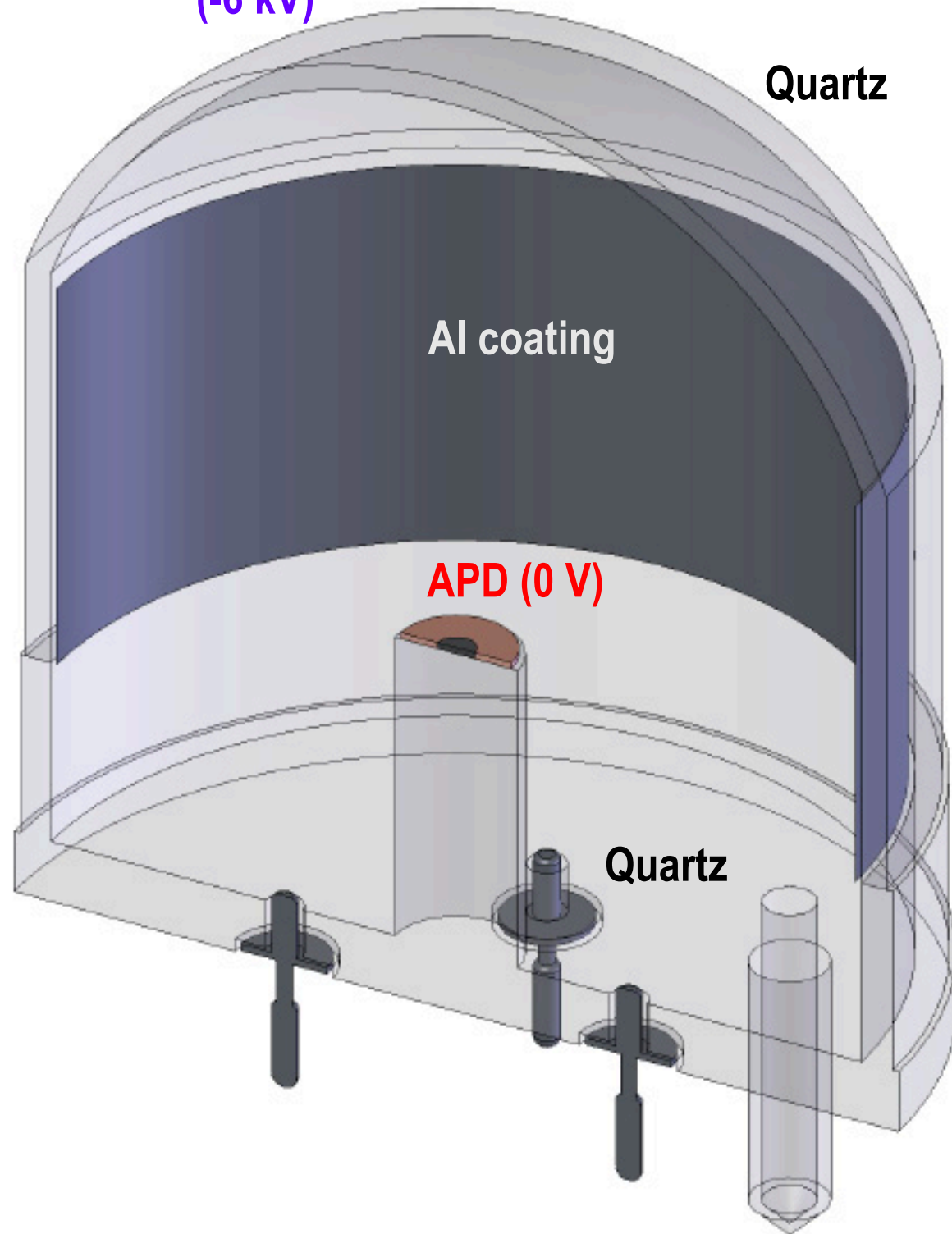
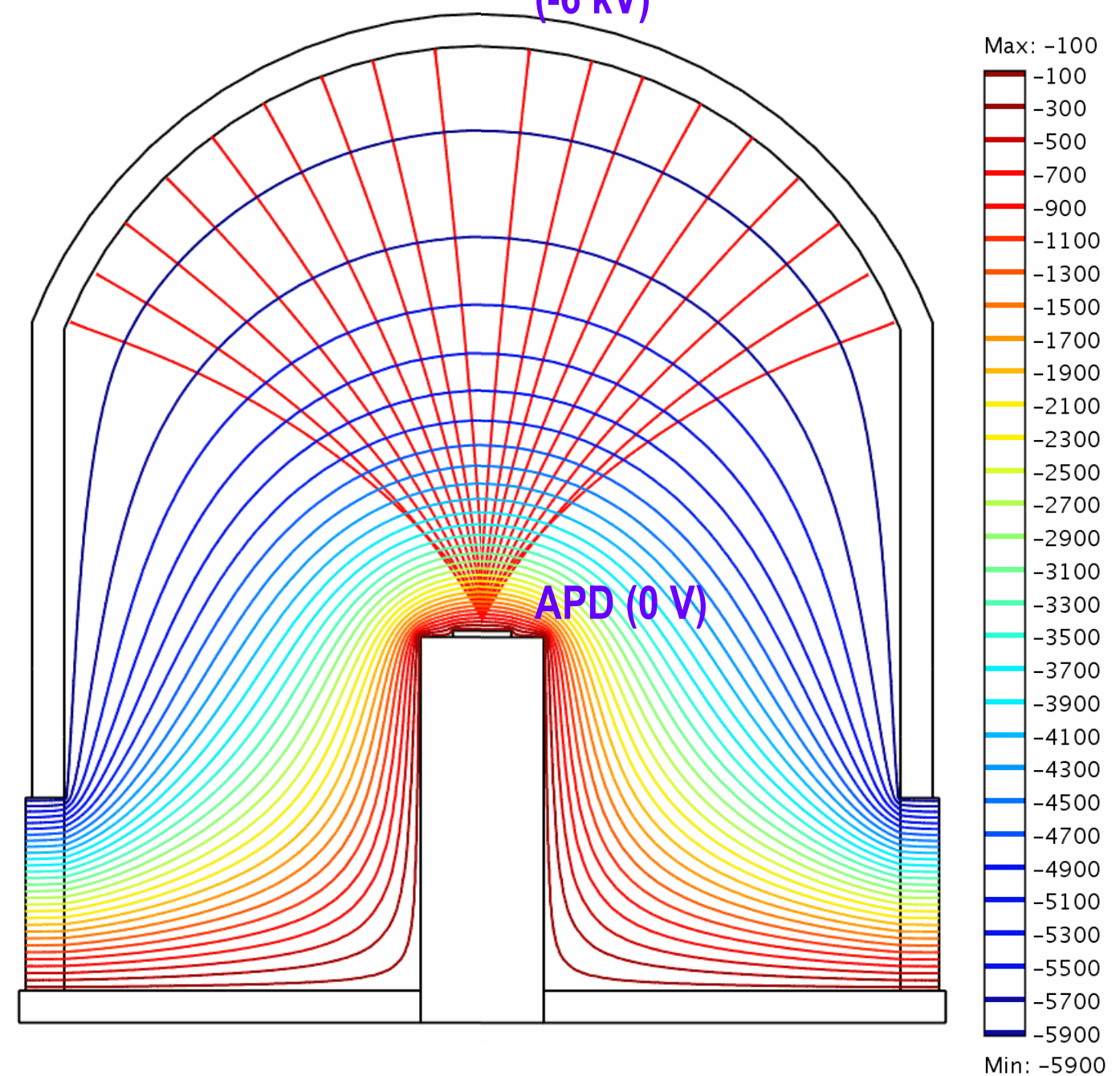
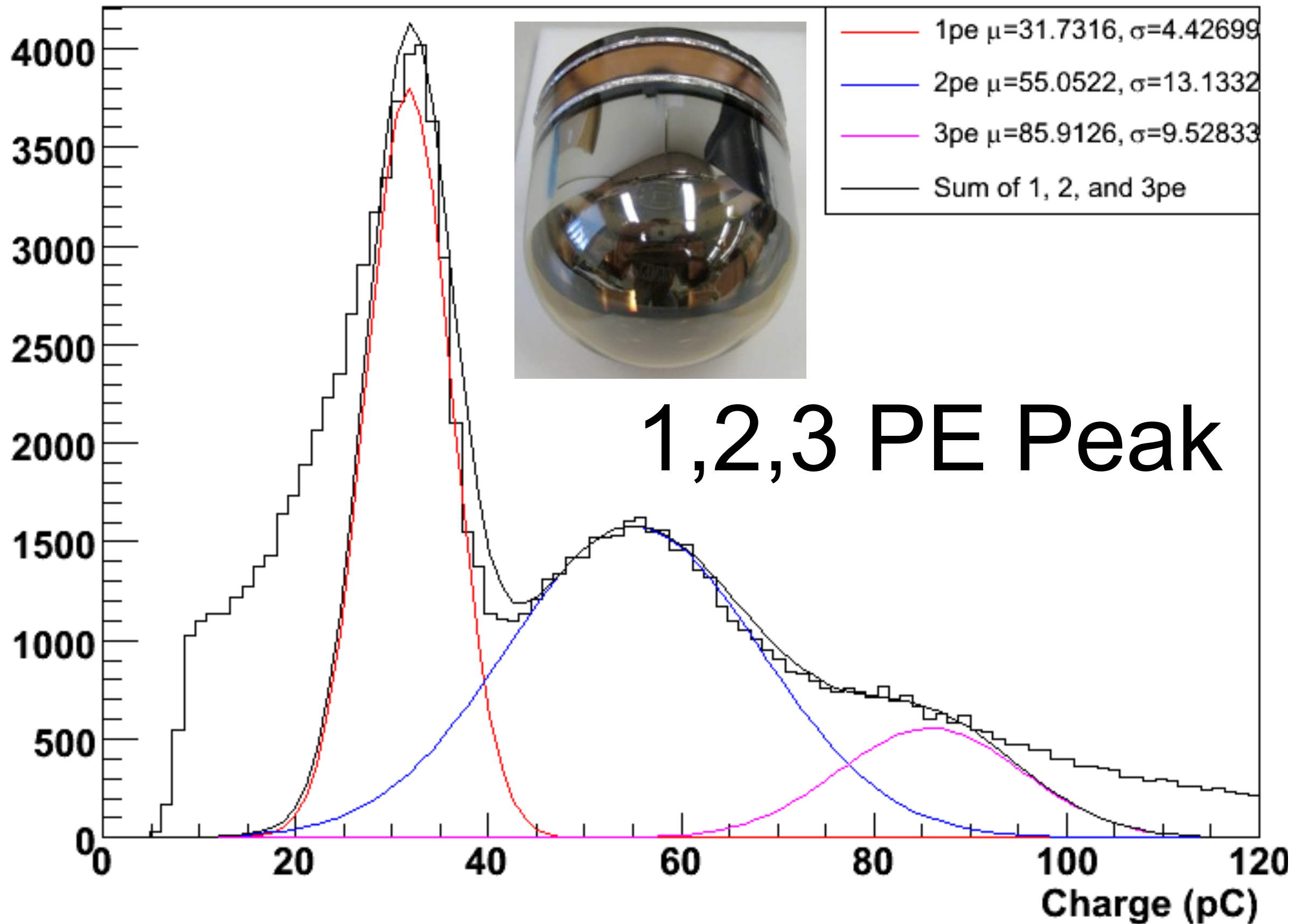


Photo Cathode
(-6 kV)

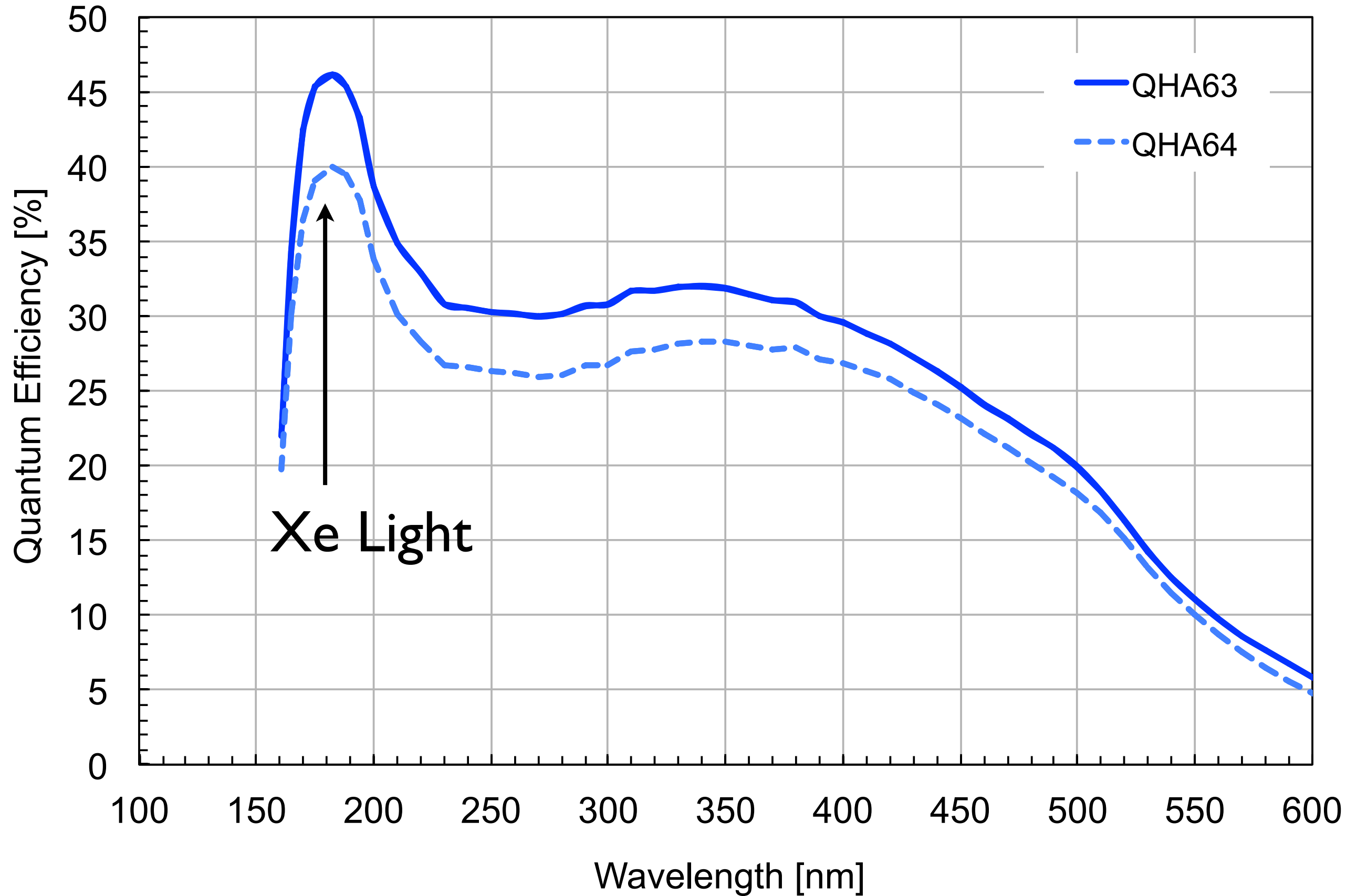


*Made by Synthetic Silica only.
US Patent pending.*

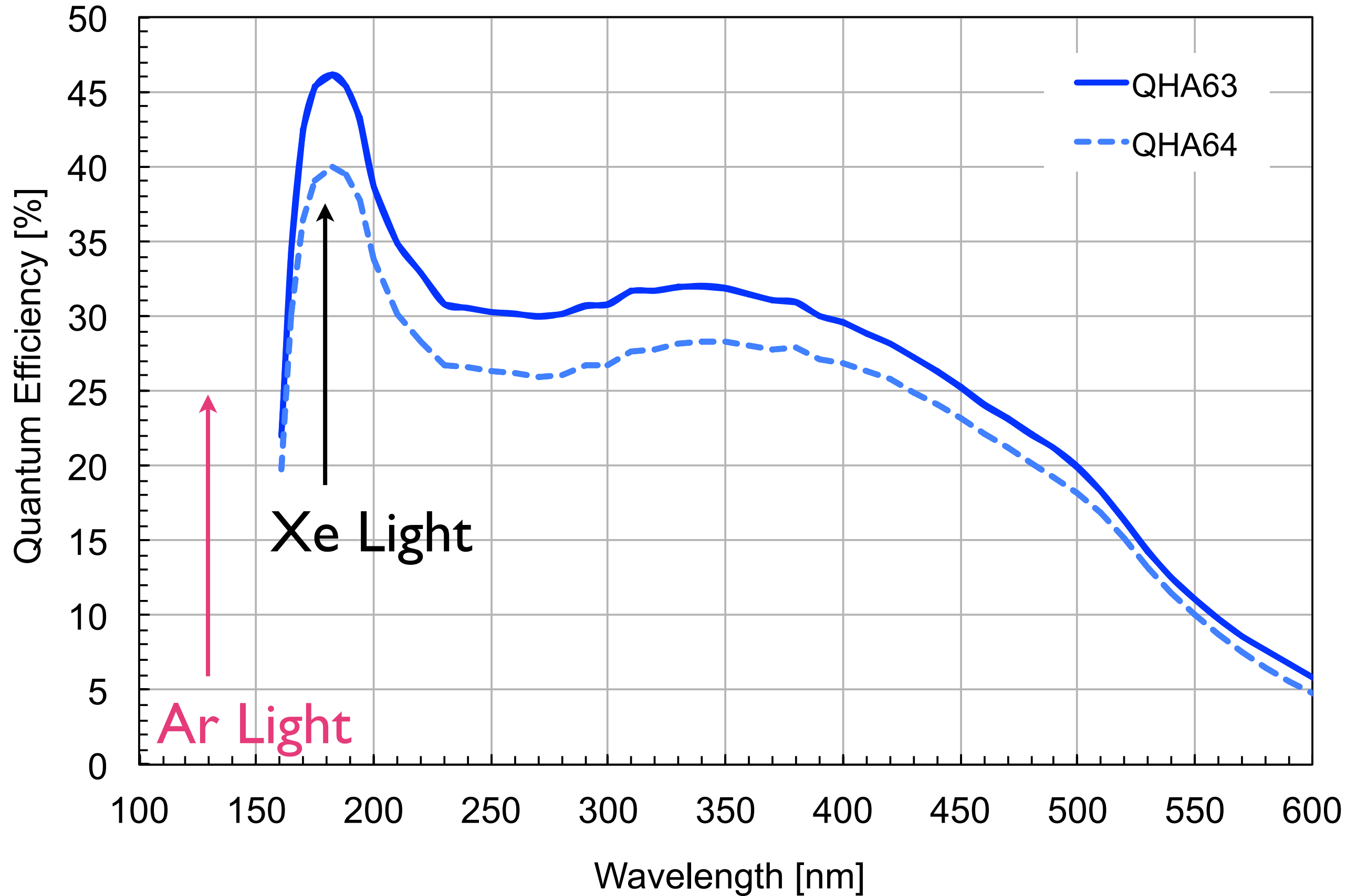
The first Scintillating lights detected by QUPID from ^{57}Co in Liquid Xenon



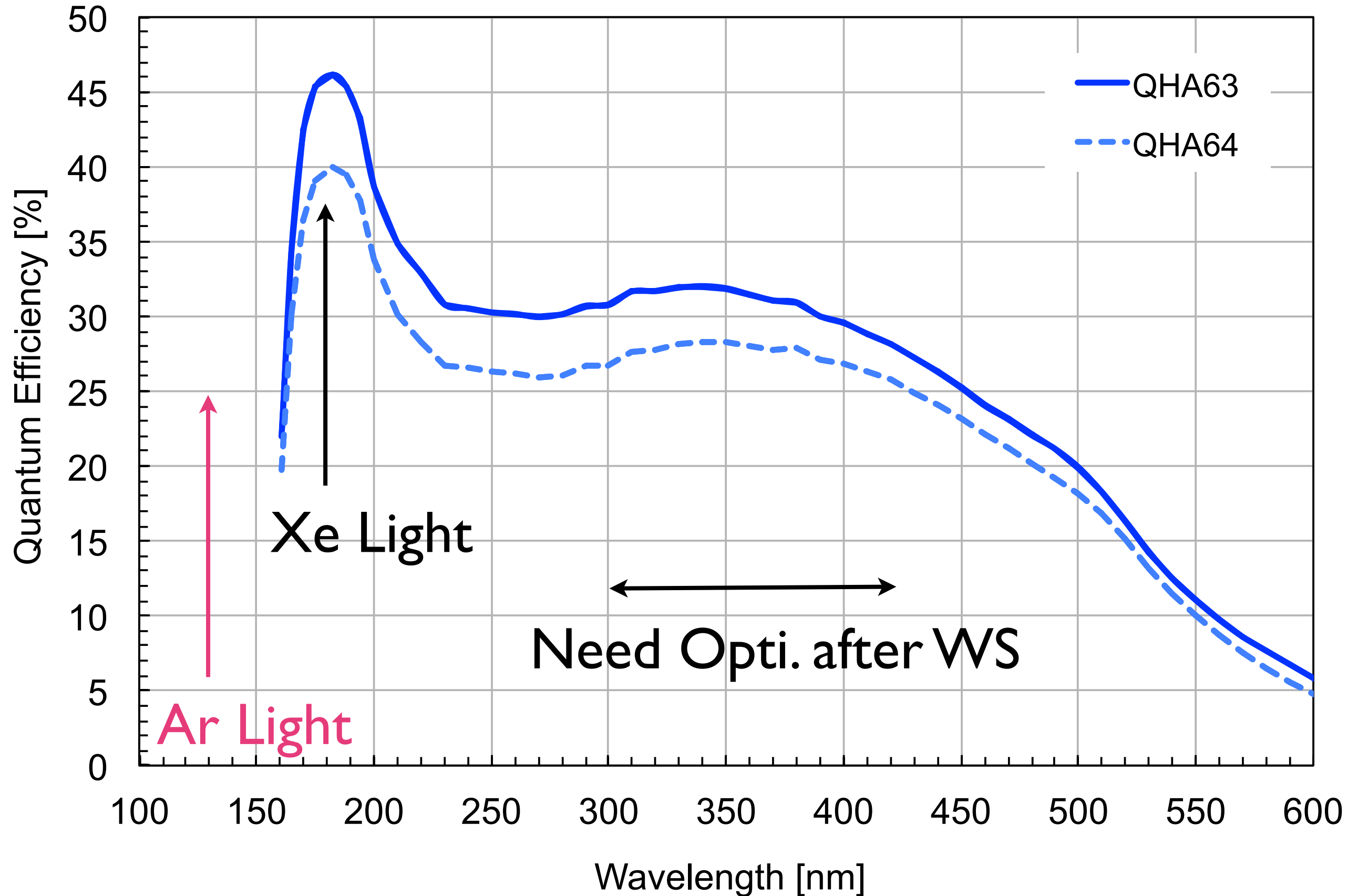
QUPID Q.E.



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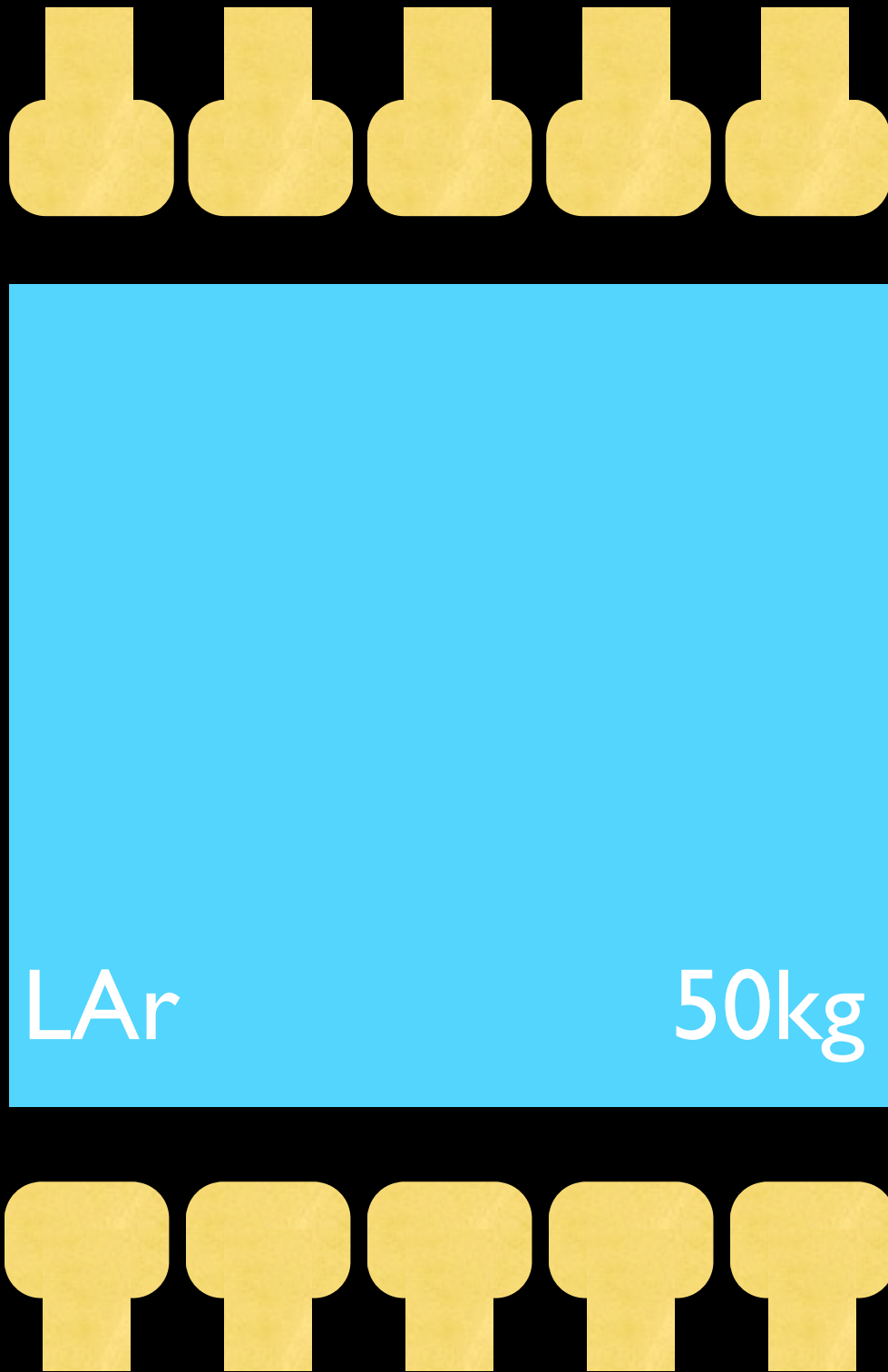


DarkSide 50 TPC

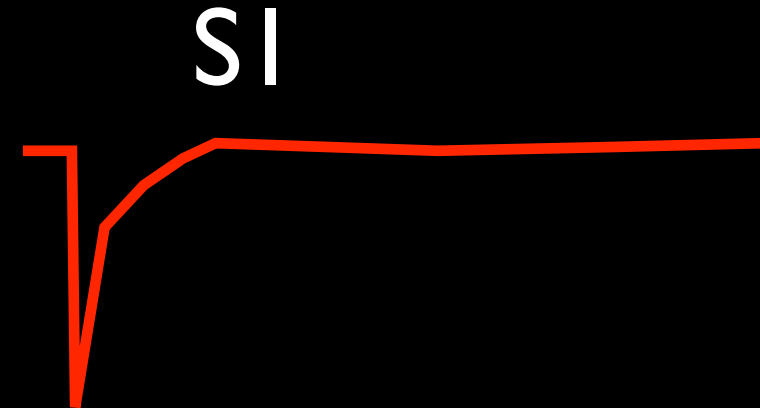
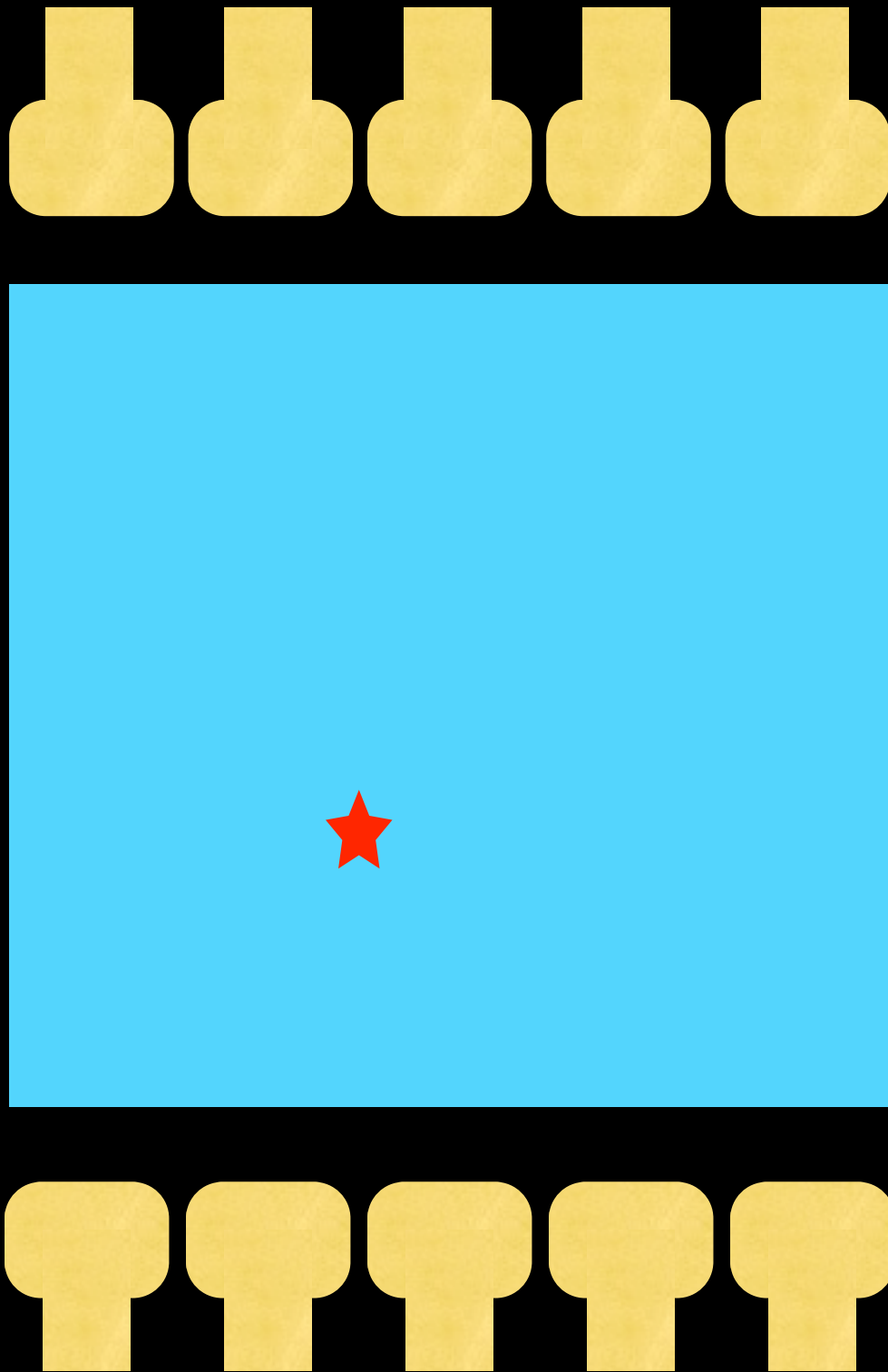
DarkSide 50 TPC



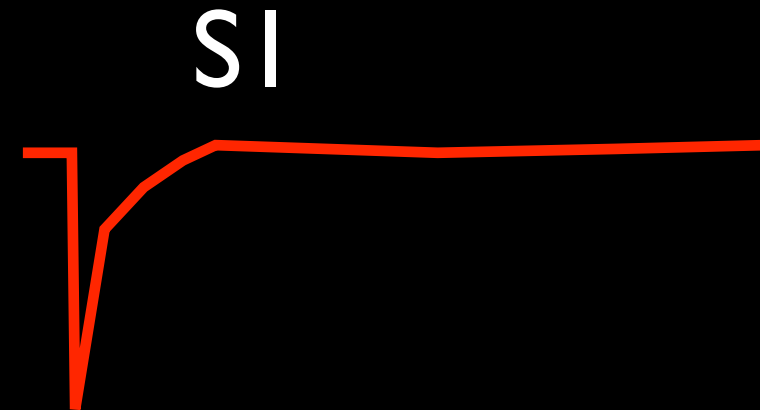
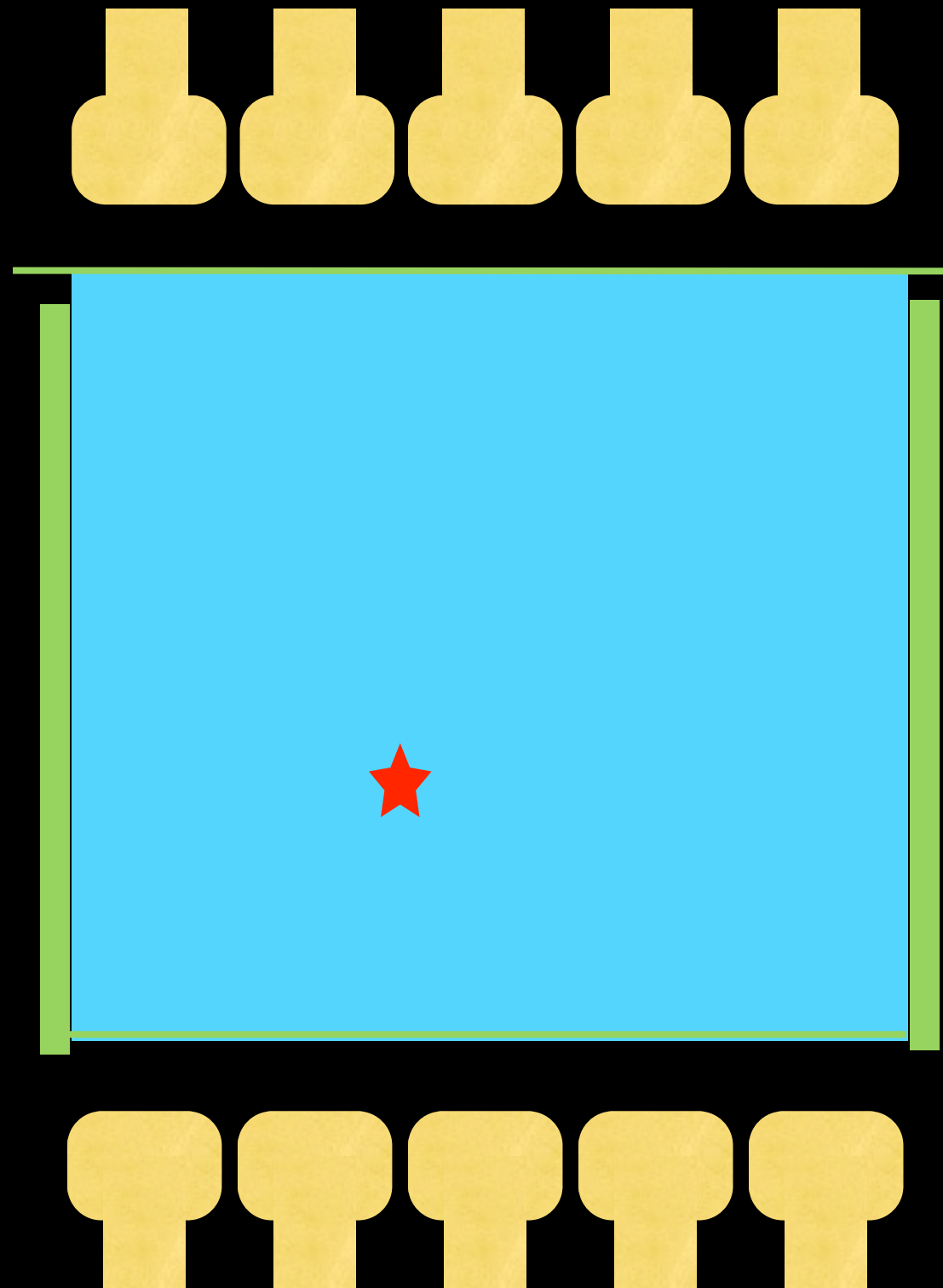
DarkSide 50 TPC



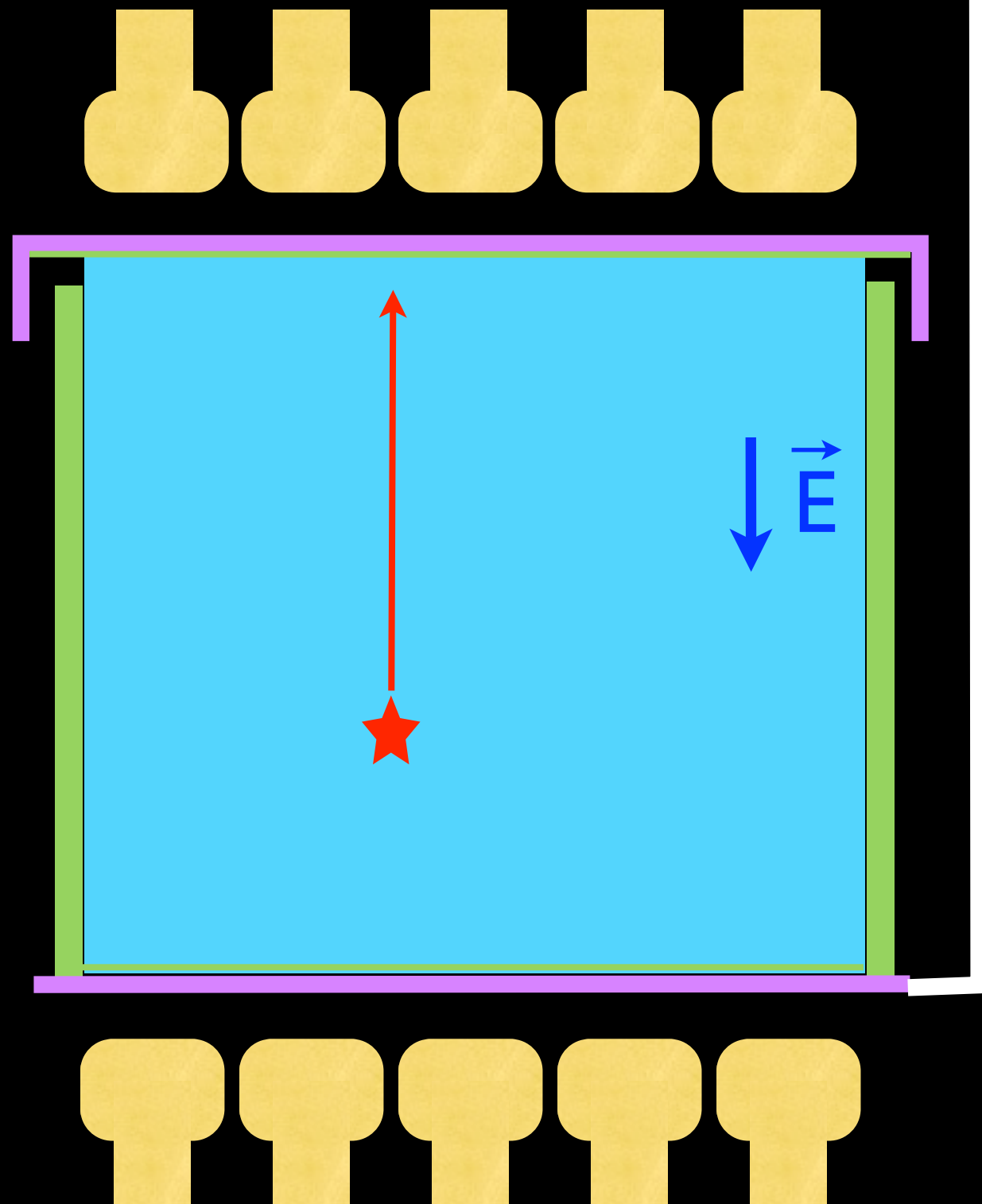
DarkSide 50 TPC



DarkSide 50 TPC



DarkSide 50 TPC

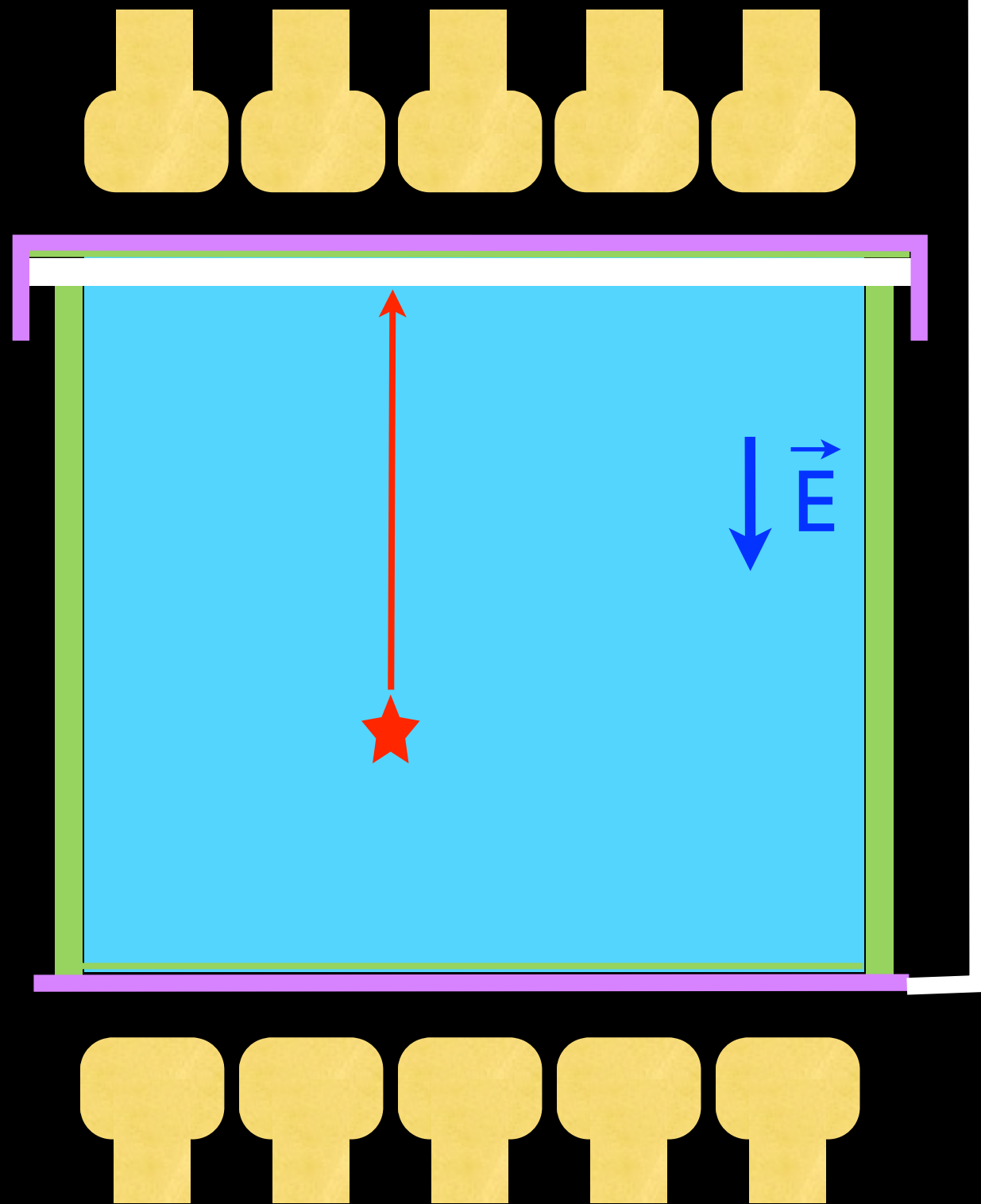


HV

SI



DarkSide 50 TPC

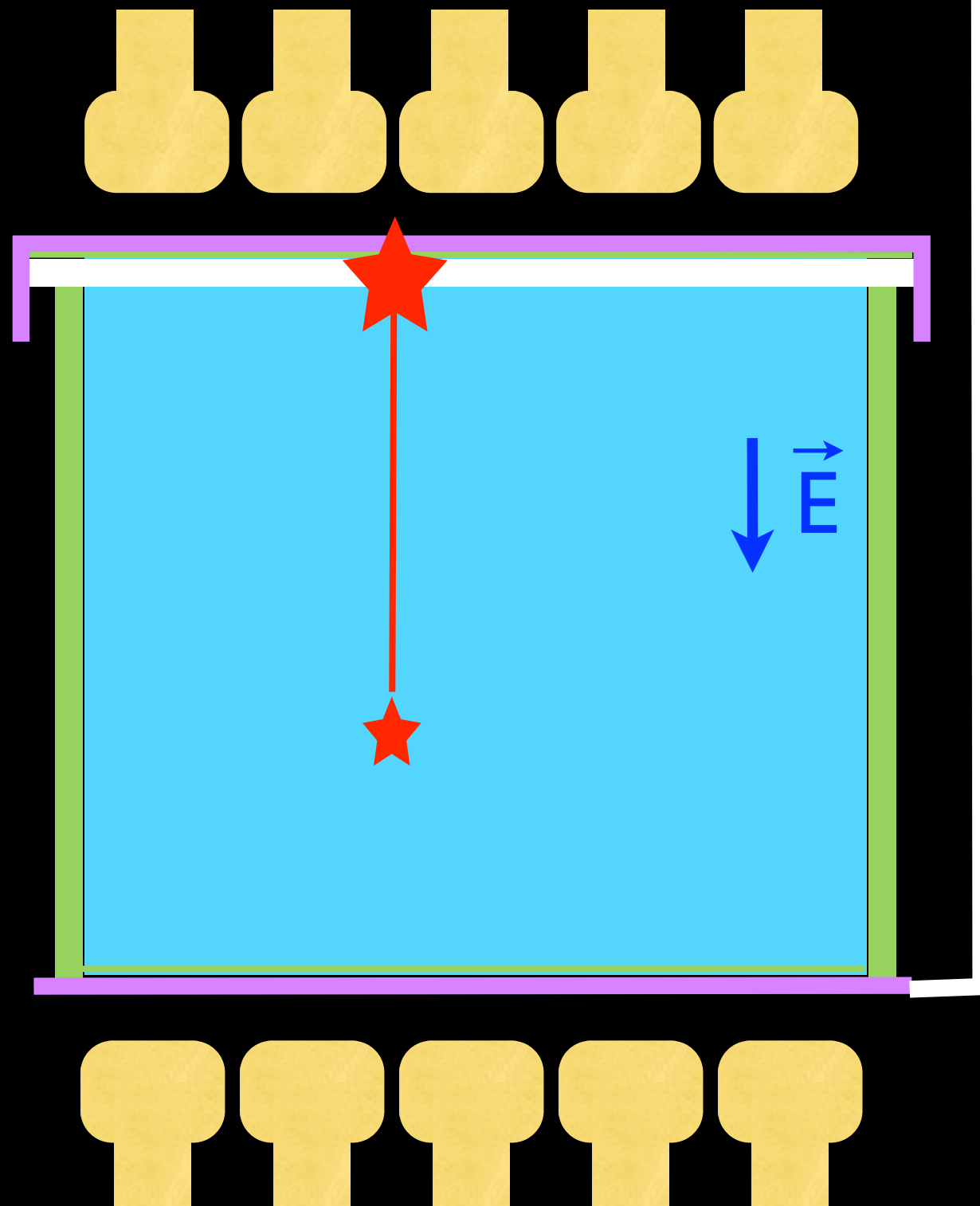


HV

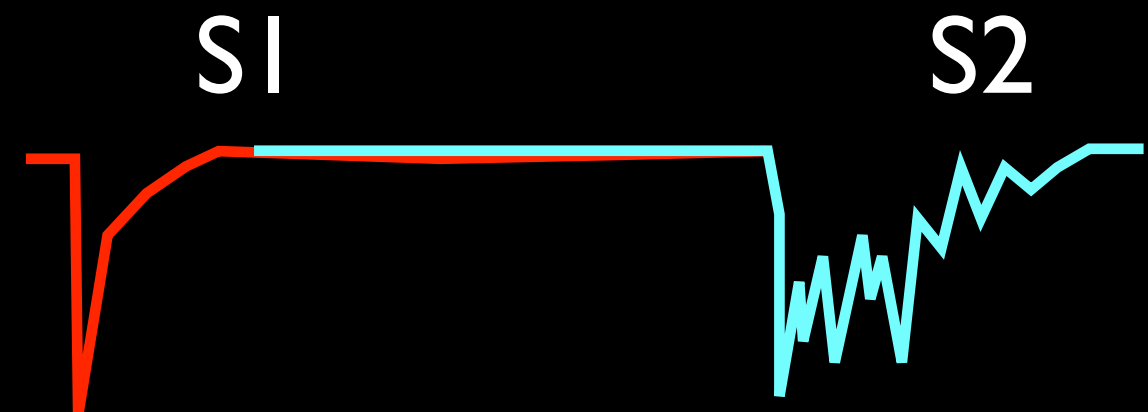
SI



DarkSide 50 TPC

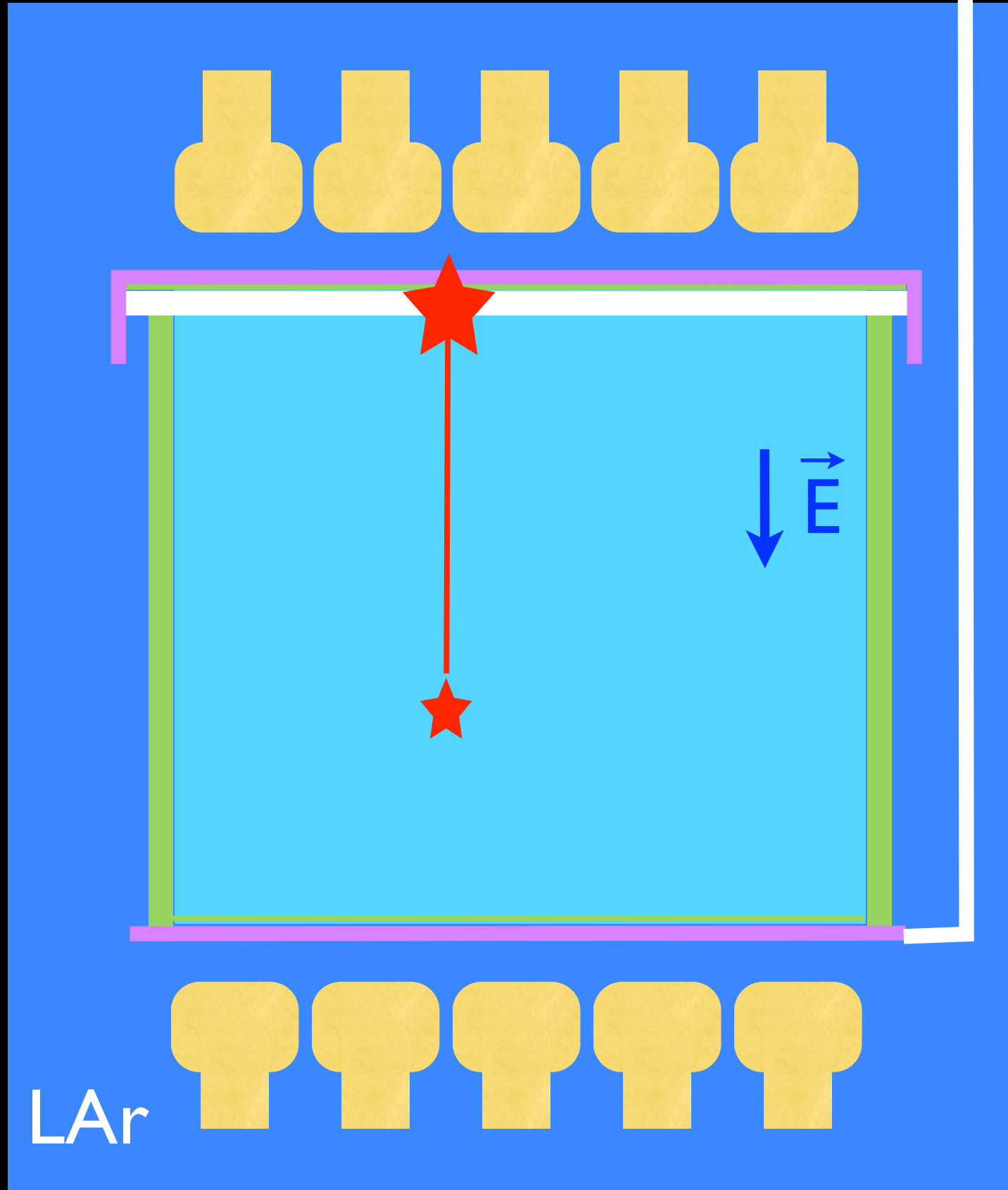


HV



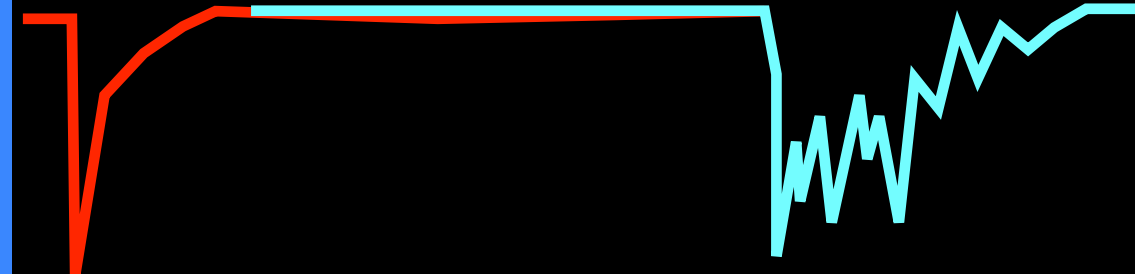
DarkSide 50 TPC

HV



S1

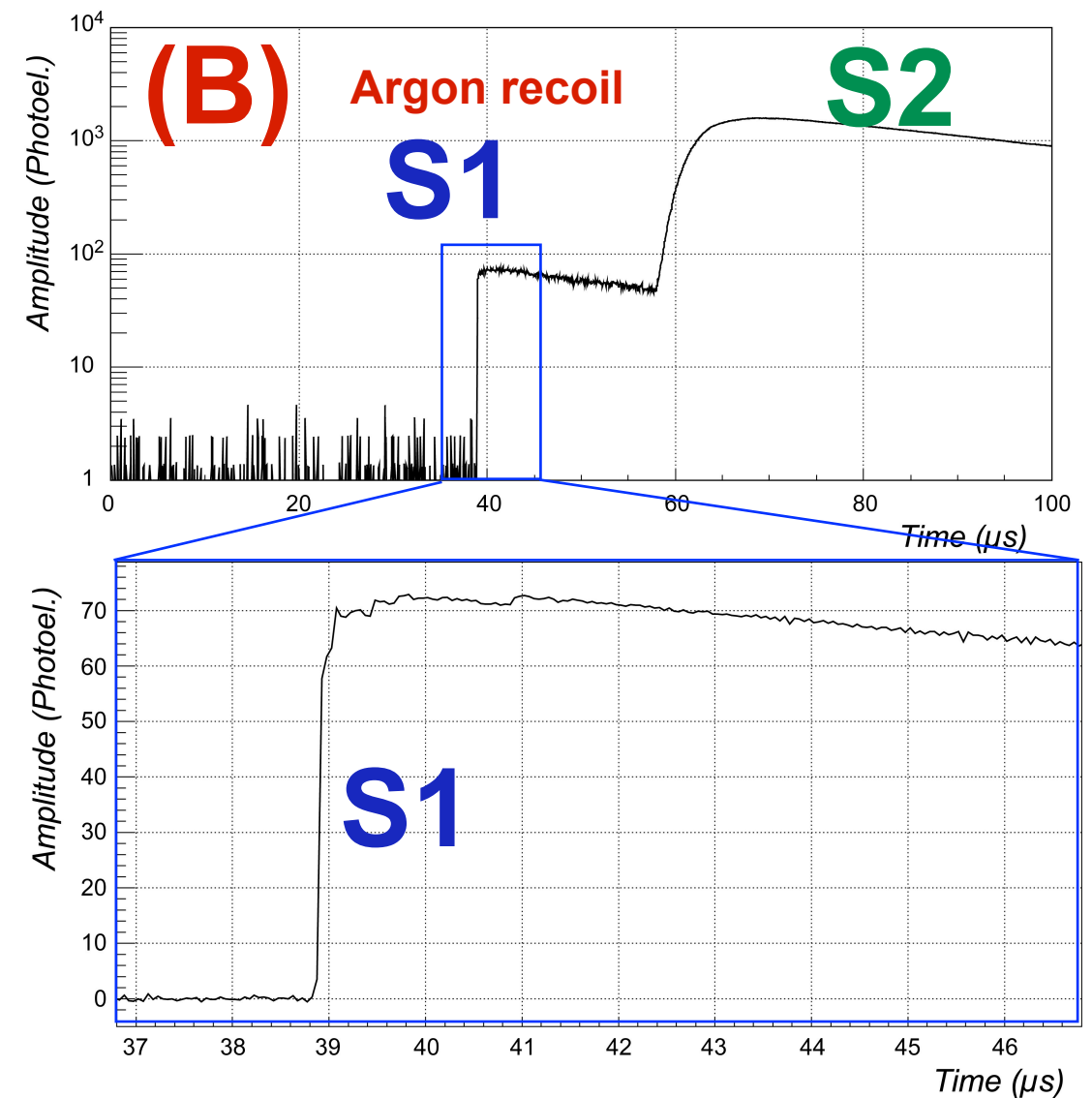
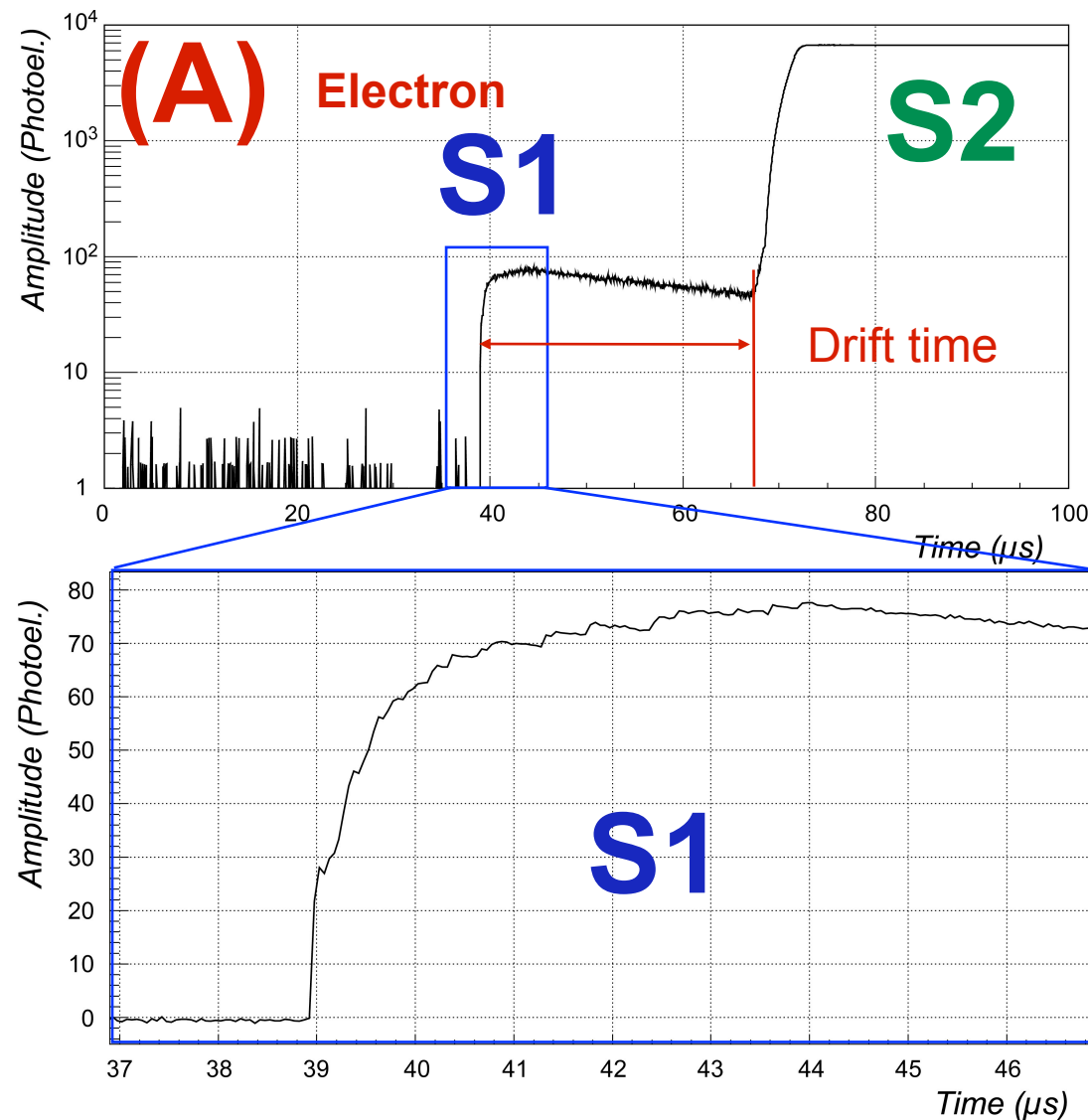
S2



- 1, S2 Signal – XY
- 2, Drift Time – Z
- 3, S2/S1 – Disc. 1
- 4, S1 PSD – Disc. 2
- 5, 4pi WS – light yield

LAr

First Two Discrimination Methods



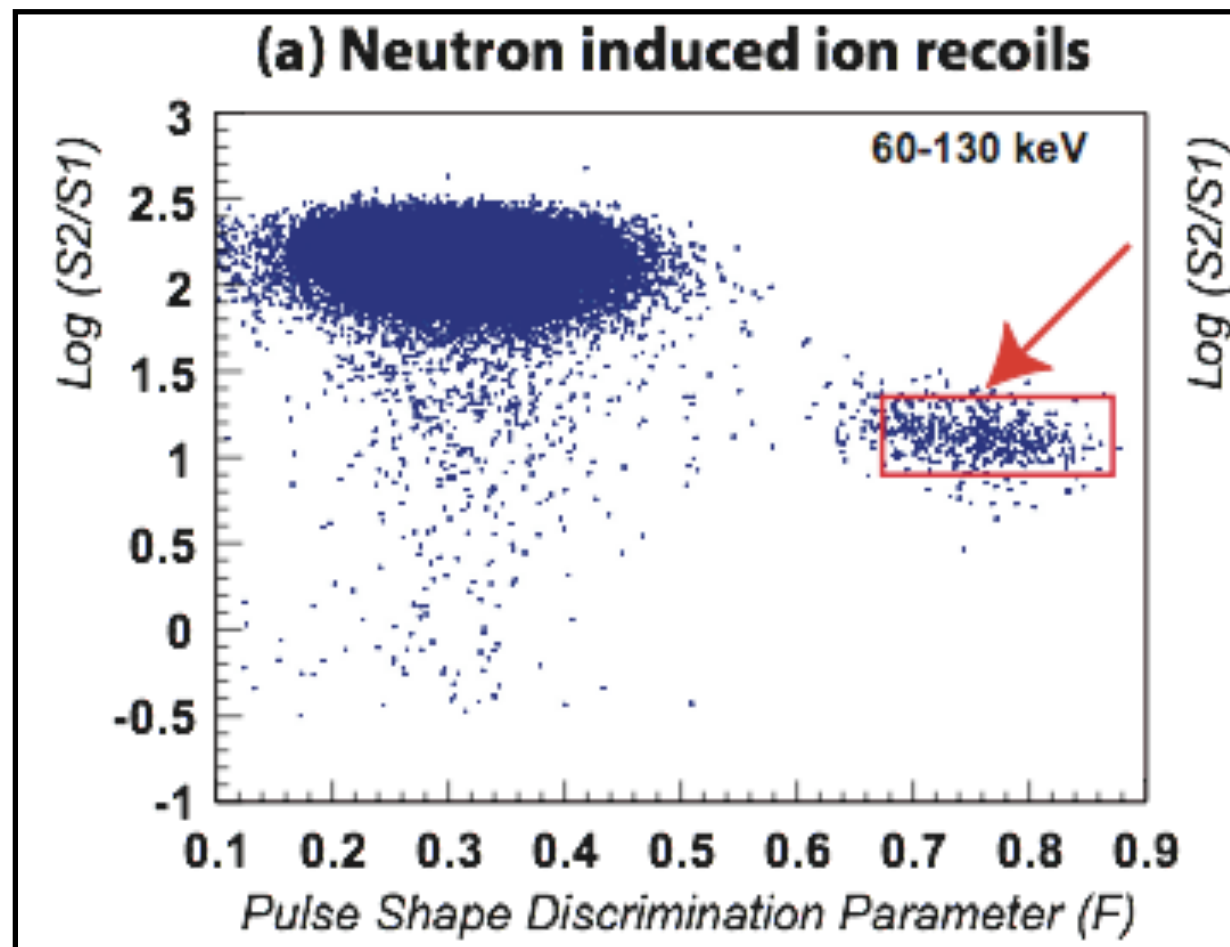
Events are characterized by:

- the ratio $S2/S1$ between the primary (S1) and secondary (S2)
- the rising time of the S1 signal

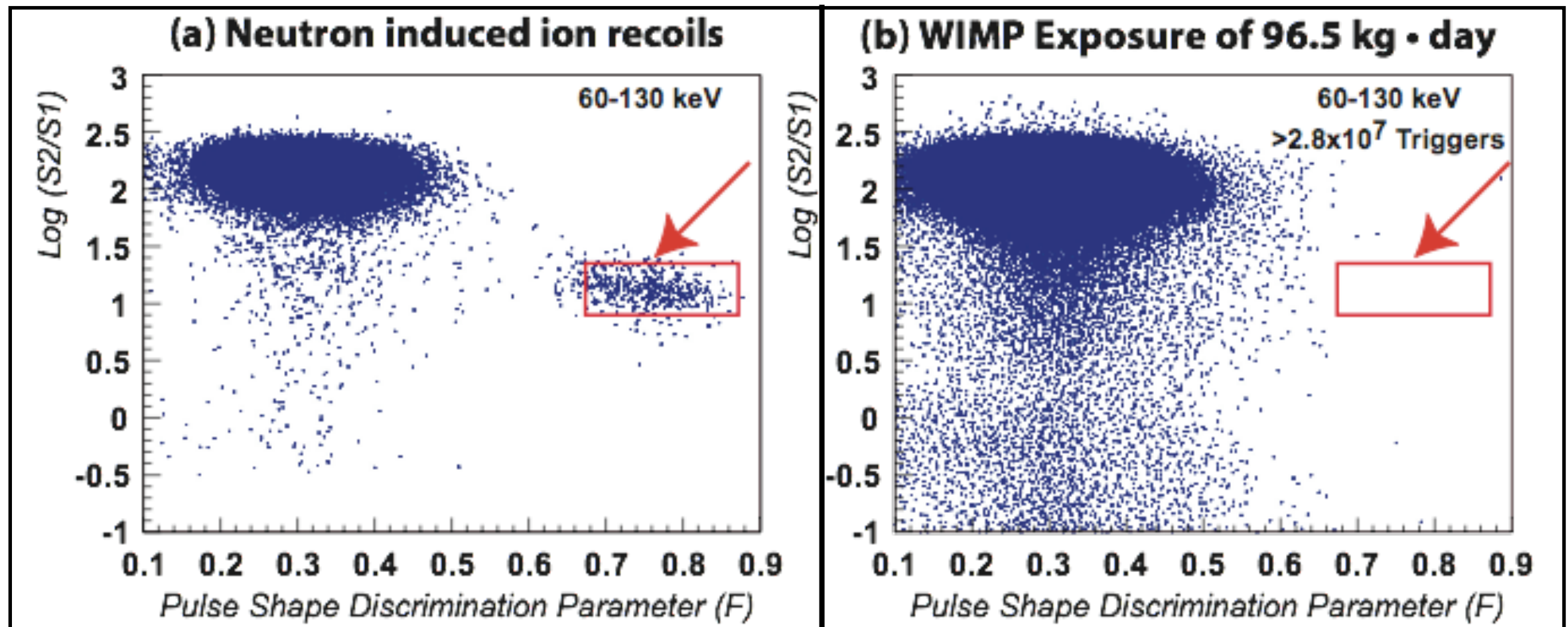
Minimum ionizing particles: high $S2/S1$ ratio (~ 100) and by slow S1 signal

Ar recoils: low (≤ 10) $S2/S1$ ratio and fast S1 signal

First Dark Matter Results



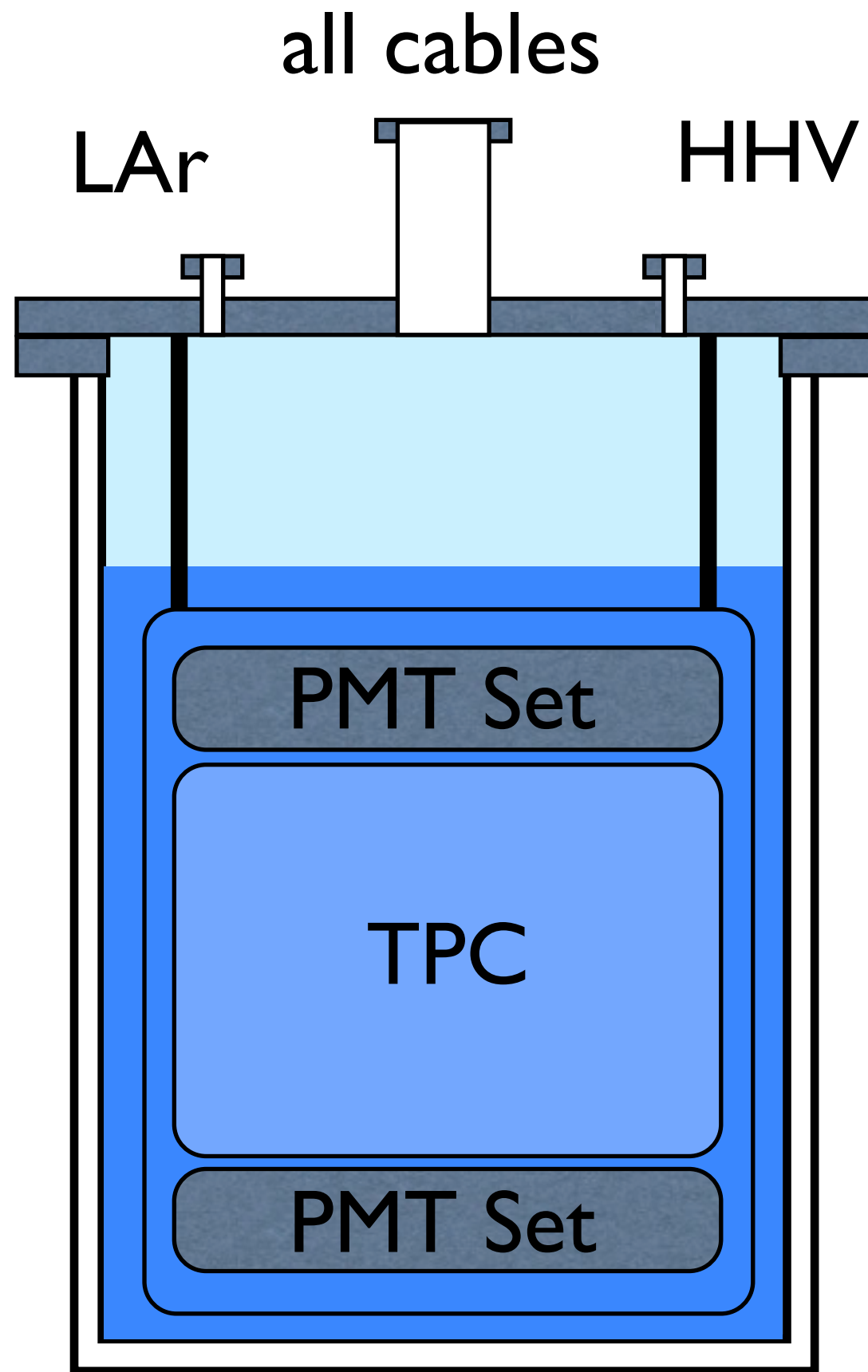
First Dark Matter Results



Events in the recoils window during
the WIMP search run: zero

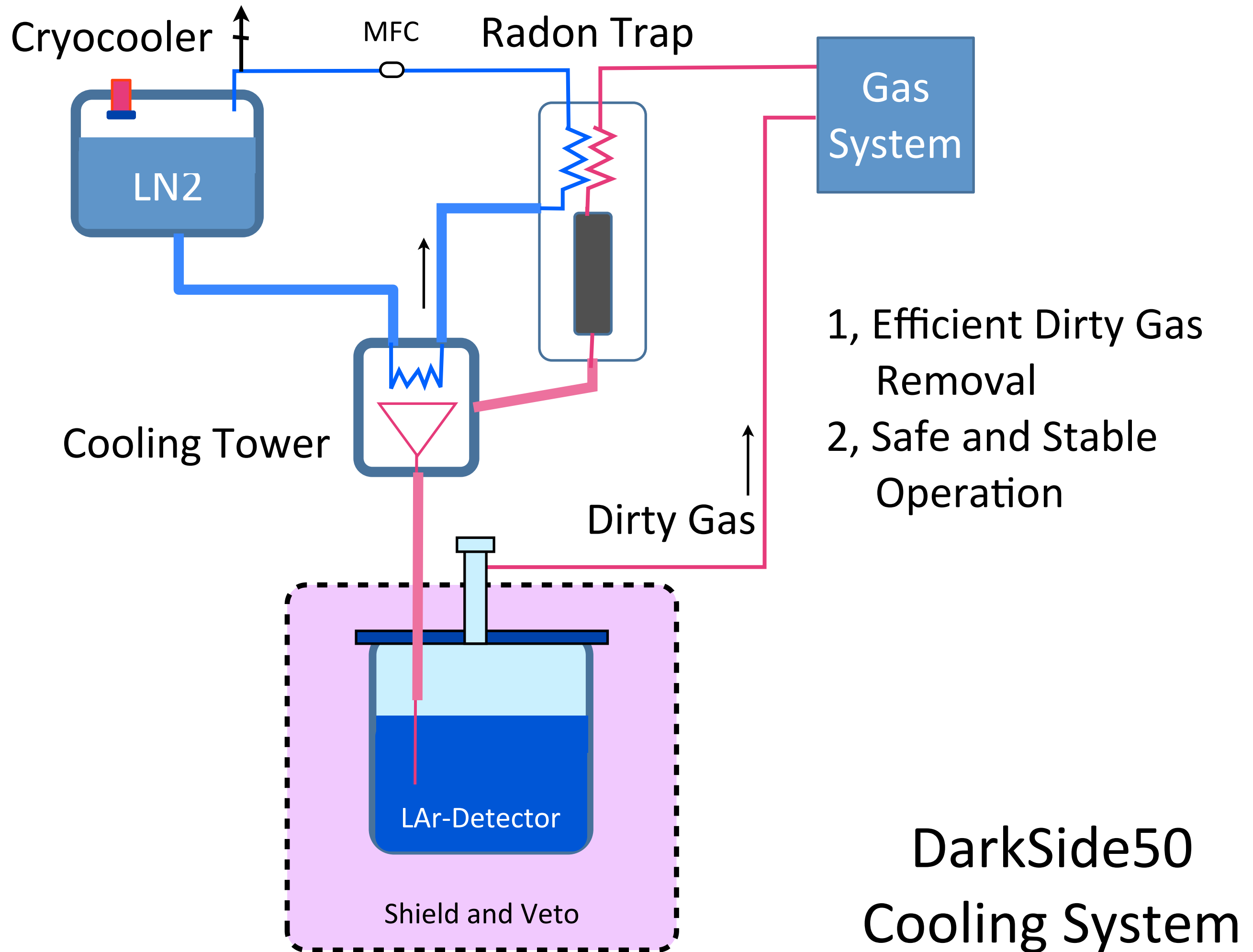
P. Benetti et al. (WARP Collaboration), *Astropart. Phys.* **28**, 495 (2008)

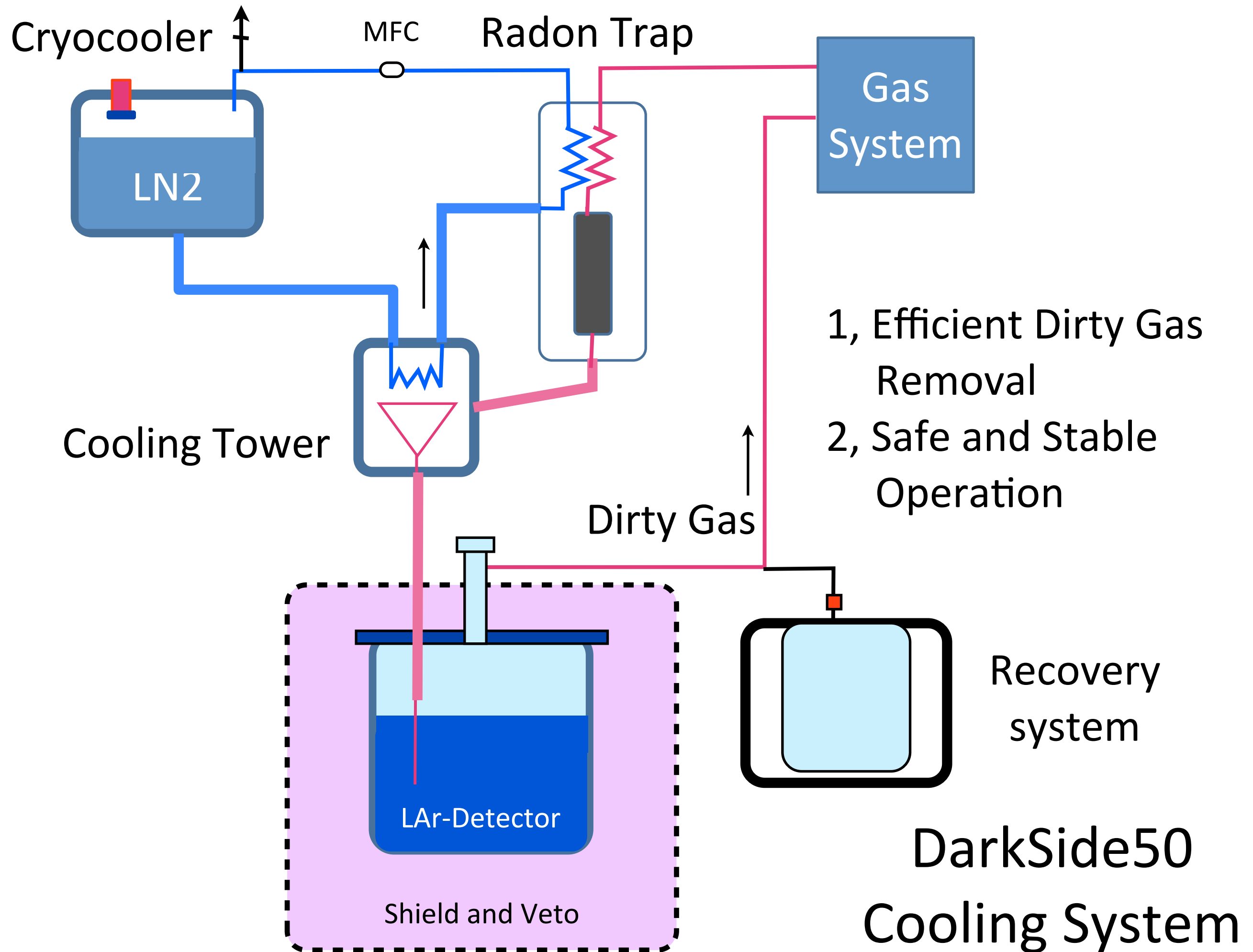
Cryostat and TPC



for the ease of installation,
operation, maintenance, gas
circulation loop for purity and
safety:
minimize number of ports and
seals

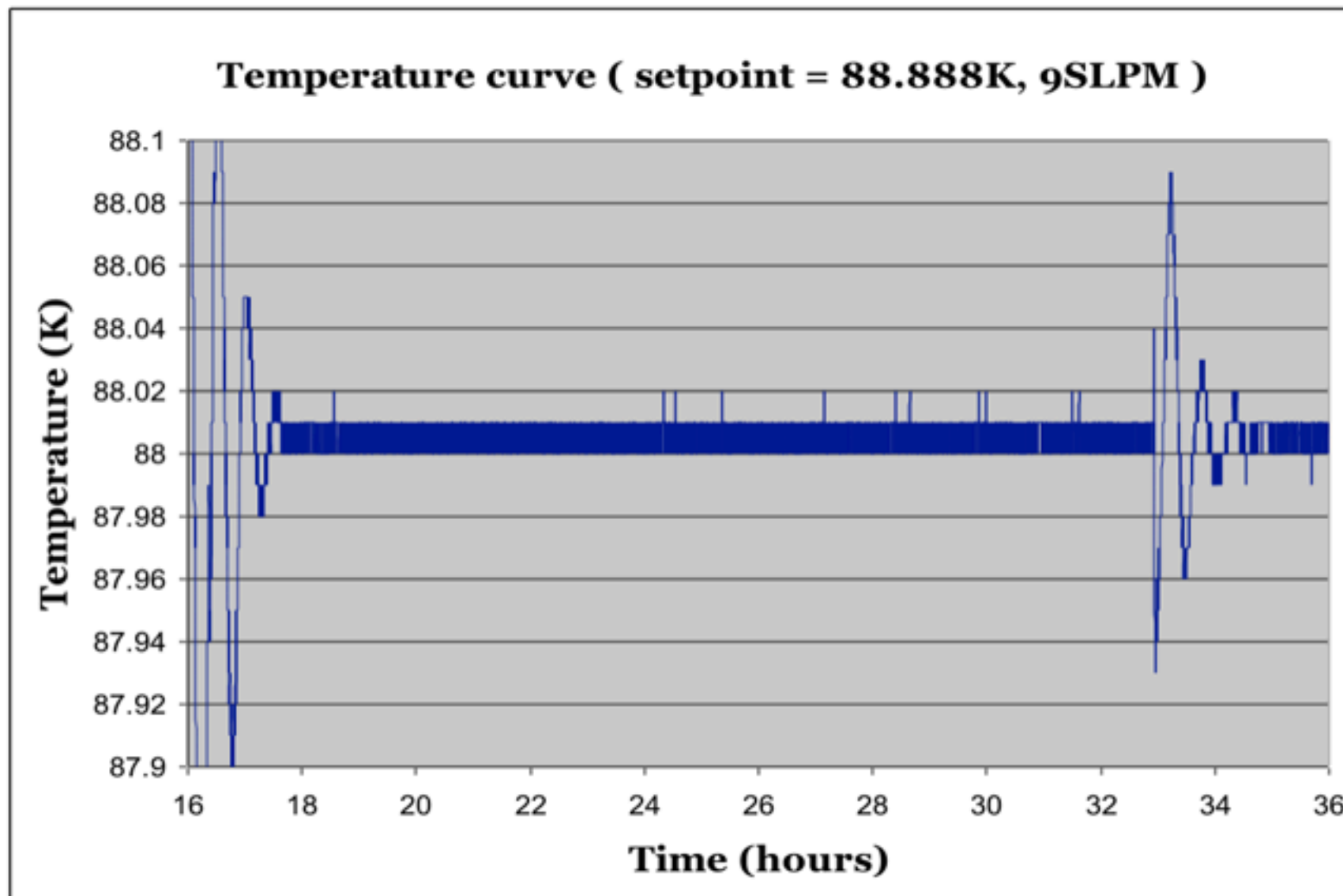
- 1, Open Mouth Double Wall Dewar
- 2, Single Layer Top Flange
- 3, TPC hang on Top
- 4, All Ports on Top Flange



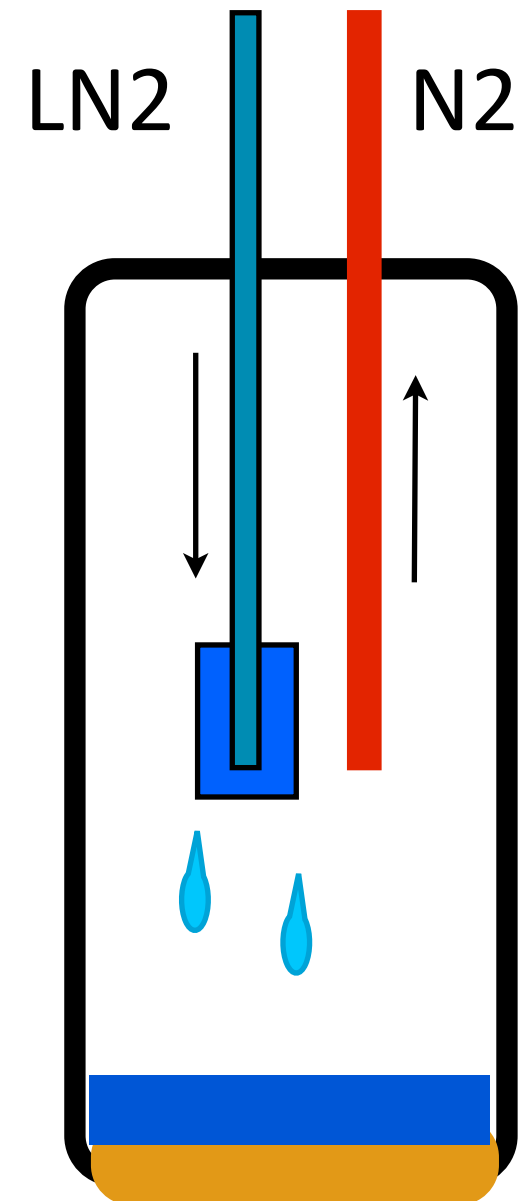


Liquid Nitrogen Cold Head

- Initial Concept Tests
- Power Controlled with MFC (PID)
- Very High Accuracy

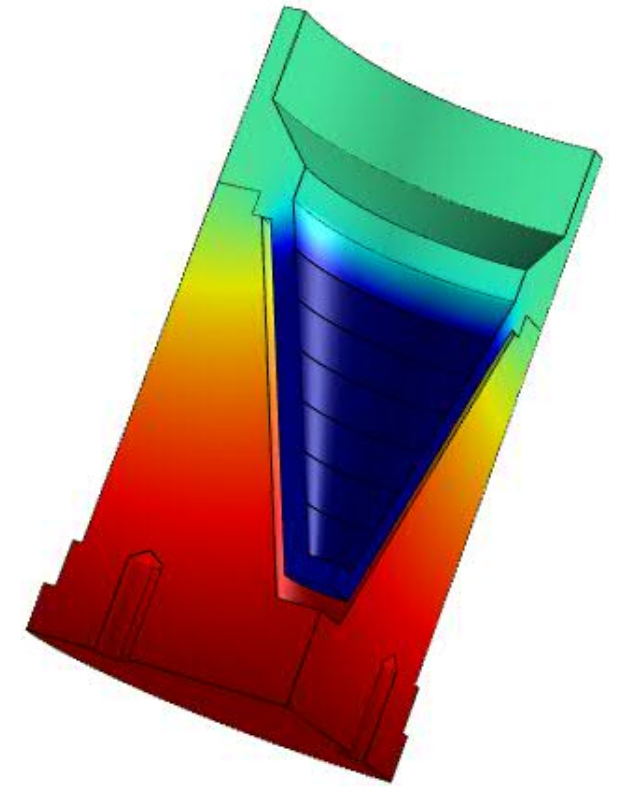


Mengyun's data Summer 2010@UCLA

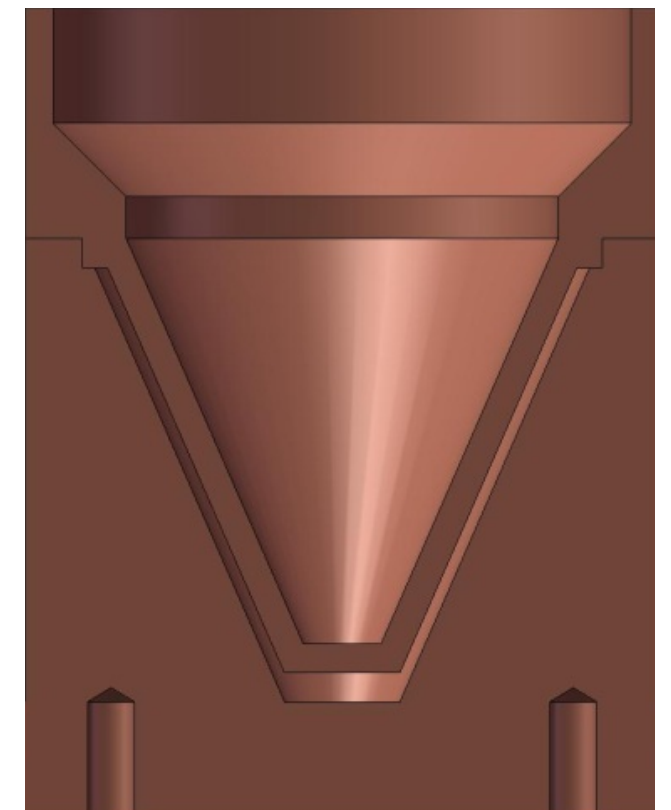


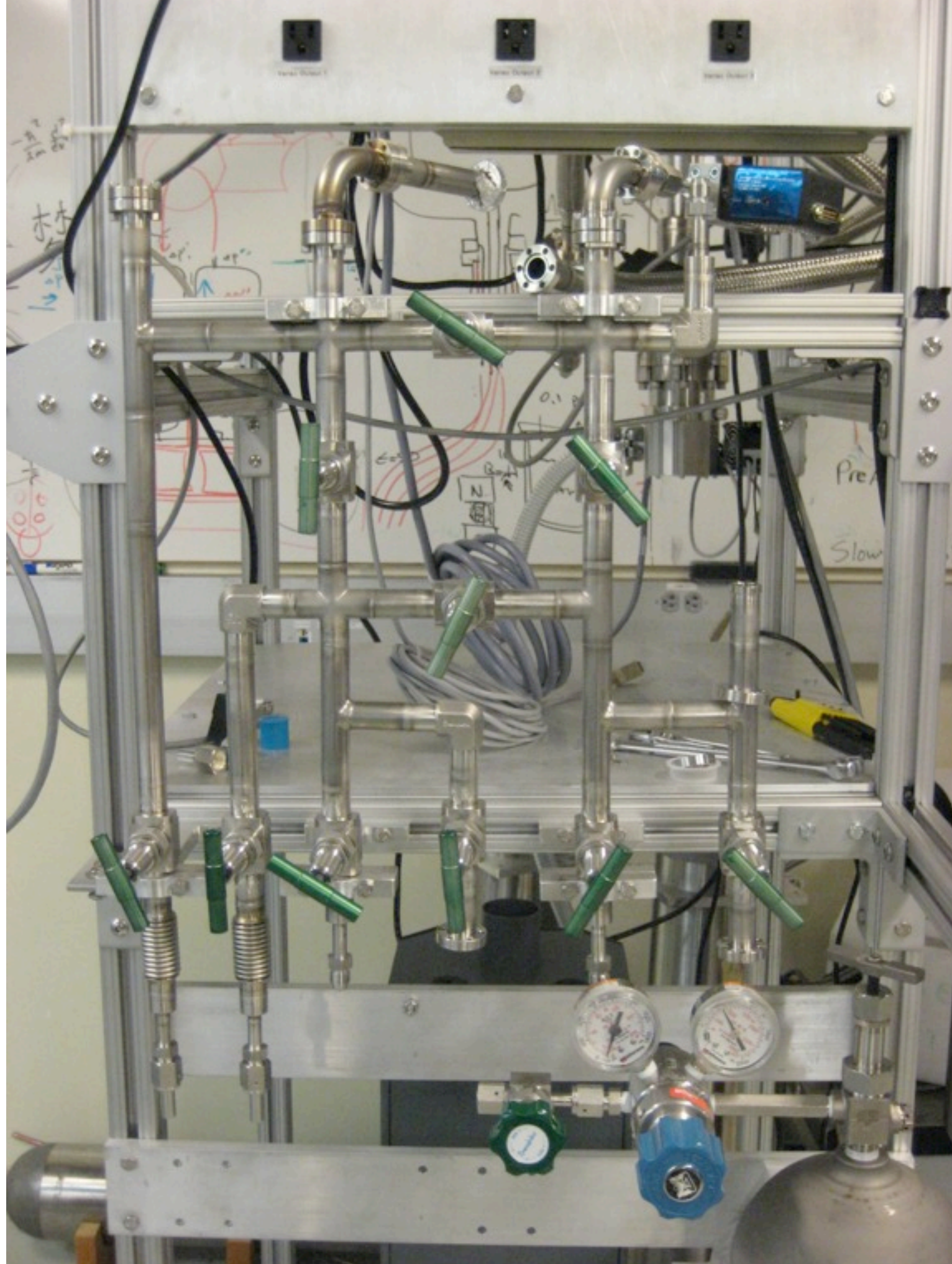
LN2 Closed Loop Cooling Tests Using the Multi-QUPID System

Stability and Safety
with Improved LN2/Ar Exchanger



multi-QUPID test

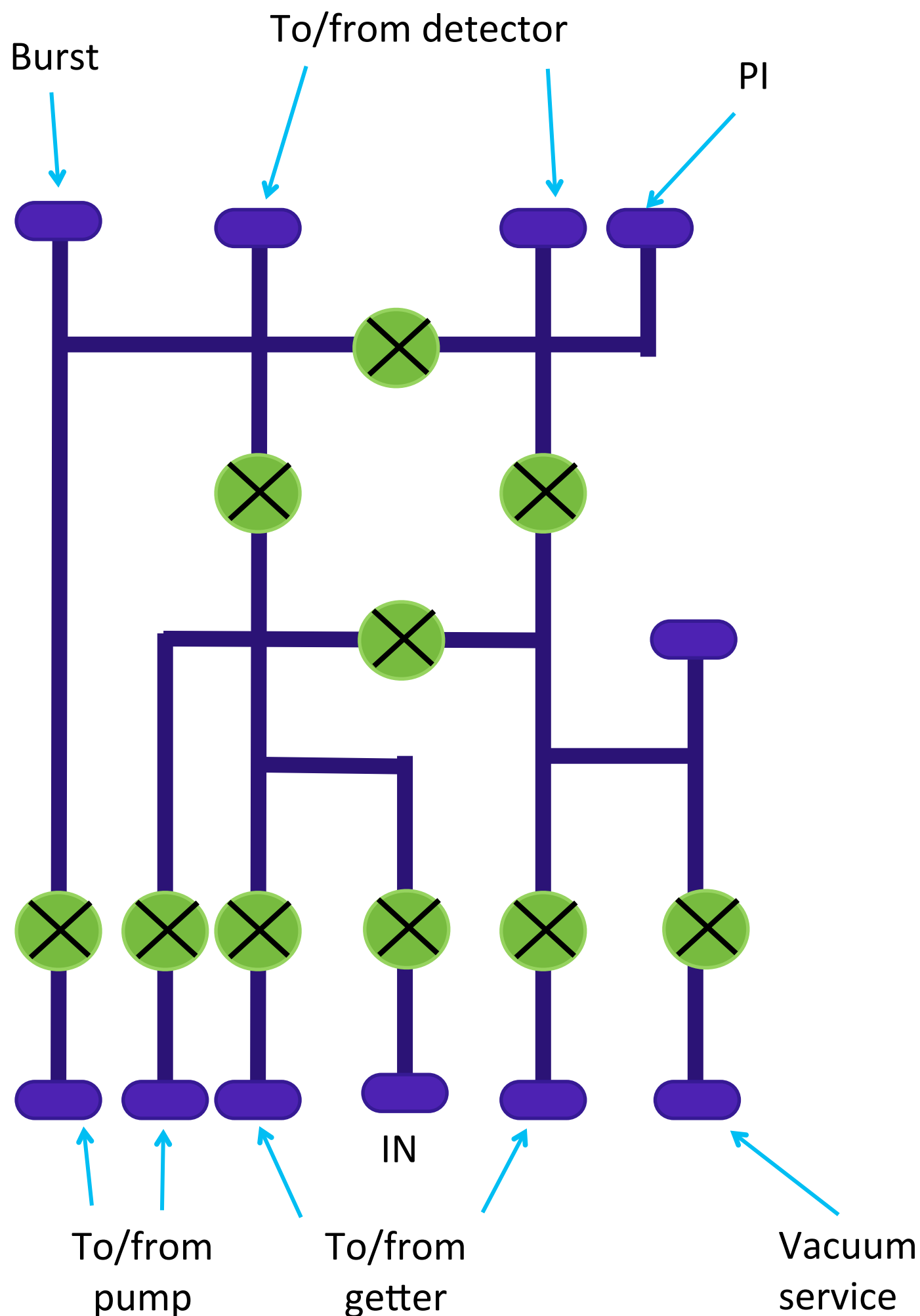




example of a gas system

All welded
(minimum number
of connection)

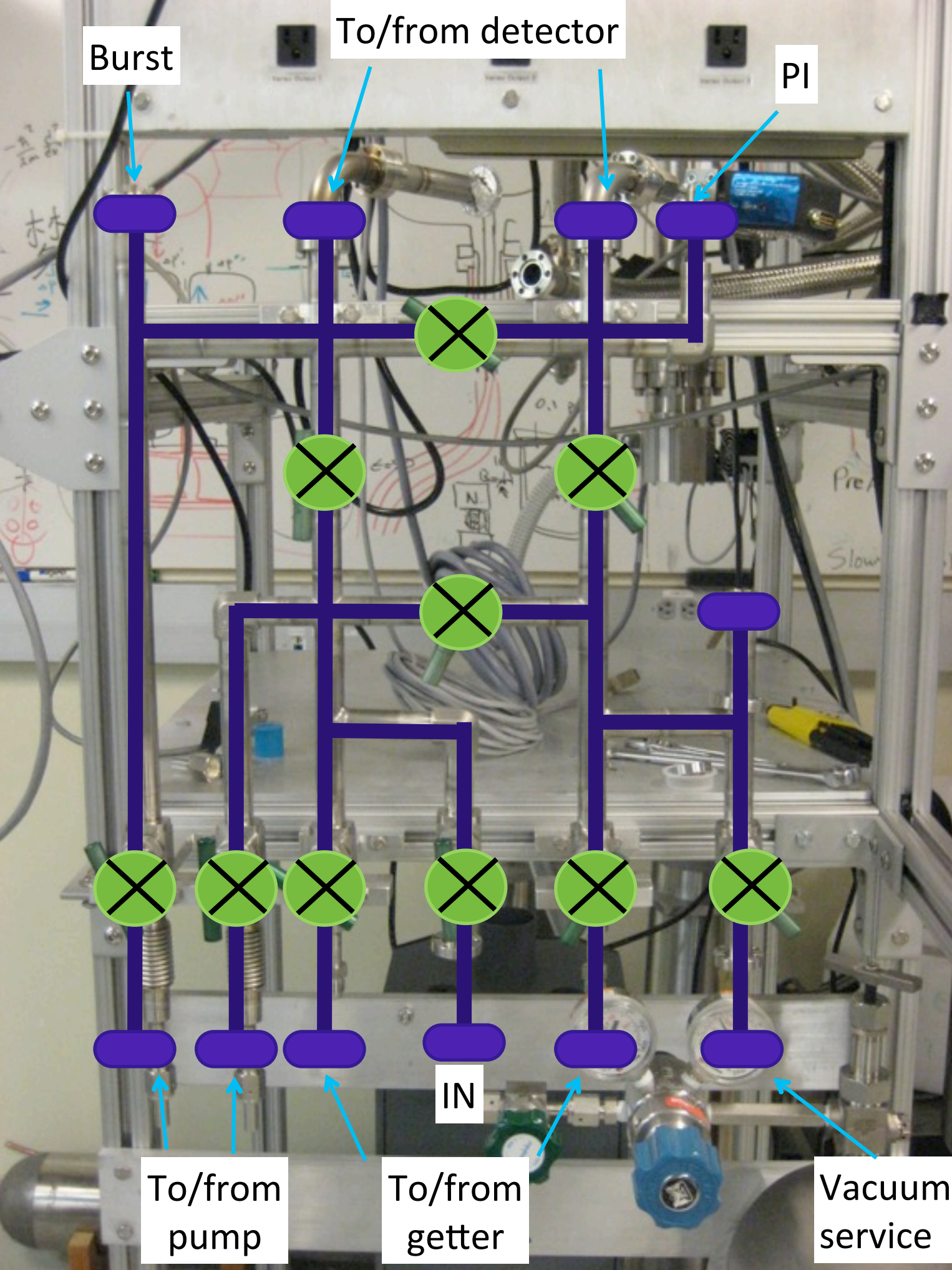
DarkSide50 gas
panel will be built
the same way
except all valves are
pneumatic
controlled



example of a gas system

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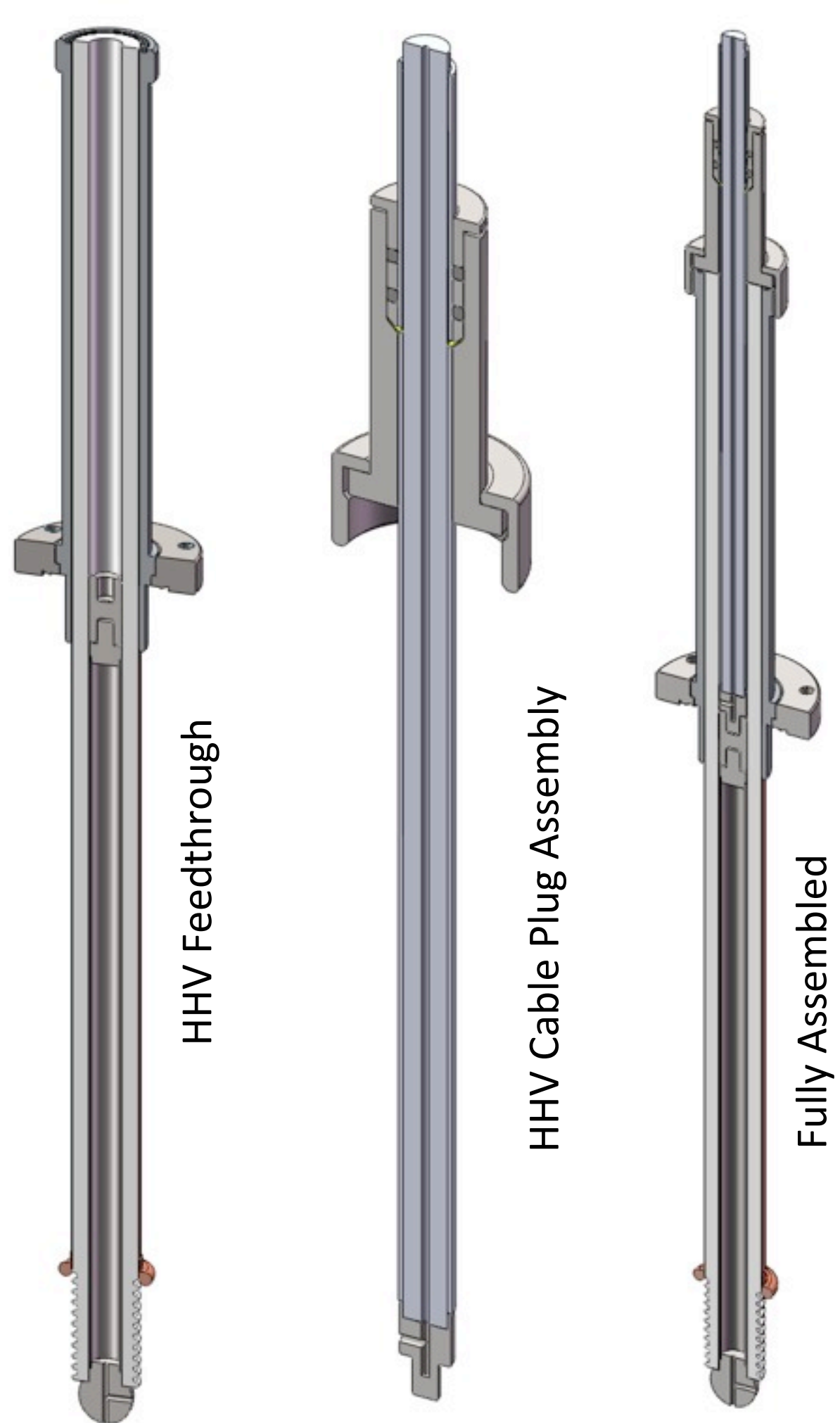
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Fails Safe Circulation Pump

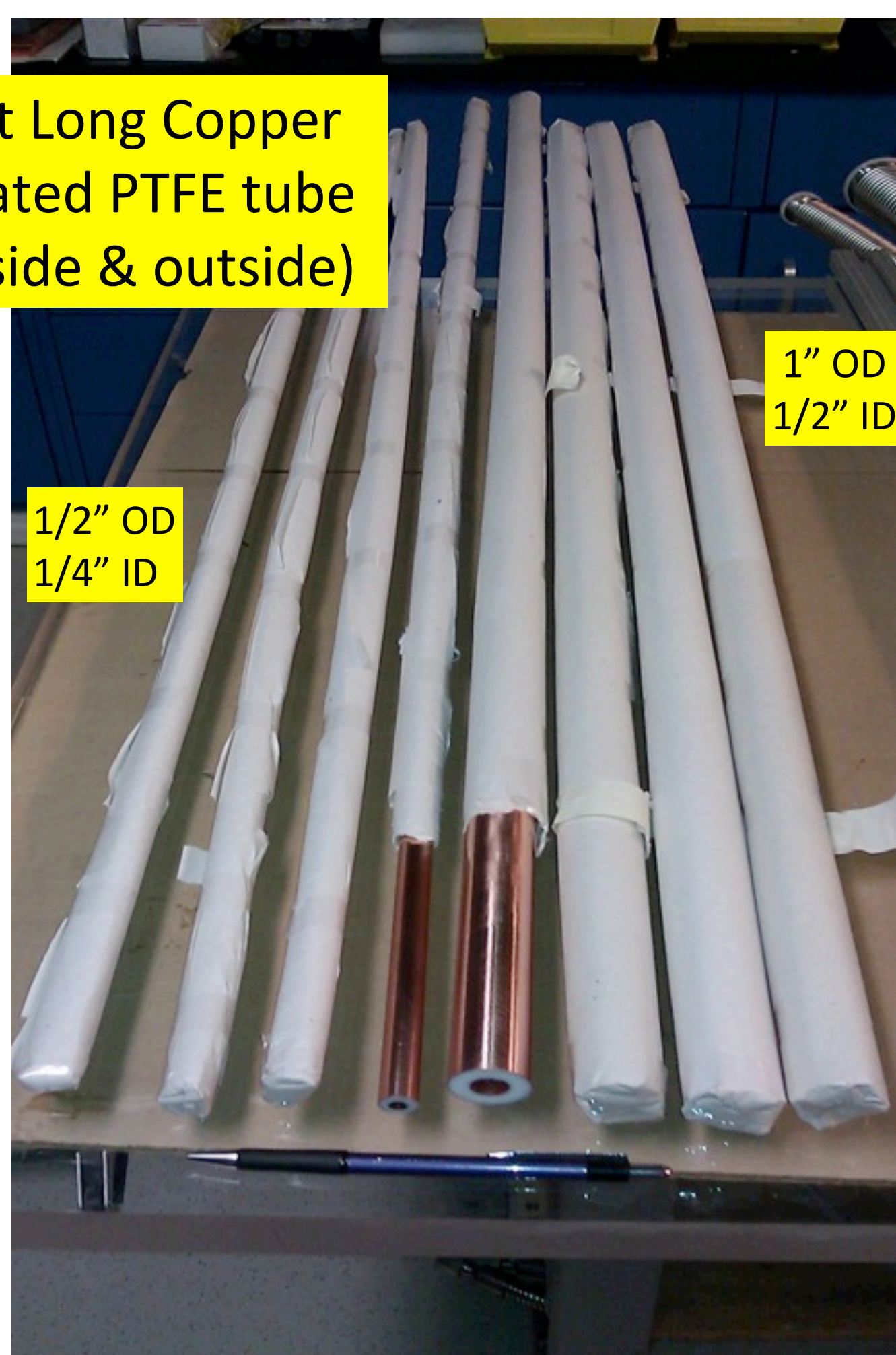
UCLA

commercial

Developing spec for the
DarkSide pump to be 100%
commercial



4 ft Long Copper Coated PTFE tube (inside & outside)



Facilities for Test



DarkSide 10kg test @Princeton

7-R11065
3" PMTs

S2 Study

TPB coated
inner wall

ITO-coated
acrylic cathode
window

Source

two-phase operation at Princeton

